



UNI-IN ALLIANCE 2026

"Exploring Frontiers for a Closed-loop Future"



12th Undergraduate Research Symposium

Organised by the Society of Industrial Scholars, Faculty of Applied Sciences,
University of Sri Jayewardenepura



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B.Sc. (Honours) Degree in Applied Sciences

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Message from Snr. Prof. M.M. Pathmalal
Vice Chancellor
University of Sri Jayewardenepura



It is with great pleasure that I extend my greetings to the organisers, participants, and distinguished guests of the **12th UNI-IN ALLIANCE Undergraduate Research Symposium**, organised by the Society of Industrial Scholars of the B.Sc. (Hons.) in Applied Sciences Degree Programme of the University of Sri Jayewardenepura.

The theme of this year's symposium, *"Exploring Frontiers for a Closed-loop Future,"* is both timely and relevant. As the world continues to face complex environmental, economic, and social challenges, the need for innovative approaches that promote sustainability, resource efficiency, and responsible development has become increasingly important. The concept of a closed-loop future encourages us to rethink conventional systems and develop solutions that minimise waste while maximising value through knowledge, innovation, and collaboration.

Research plays a vital role in this transformation. Universities have a responsibility not only to generate knowledge but also to cultivate the next generation of researchers, innovators, and professionals capable of addressing contemporary challenges. Undergraduate research serves as an important foundation in this journey by encouraging critical thinking, creativity, and scientific inquiry.

I am particularly pleased to note that this symposium provides a valuable platform for undergraduate scholars to present their research findings, exchange ideas, and engage with peers and academics from diverse disciplines. Such opportunities strengthen the research culture of the University and contribute meaningfully to the advancement of knowledge and innovation.

I commend the Society of Industrial Scholars, the academic staff, and all those involved in organising this symposium for their dedication and commitment. I also congratulate all presenters and contributors whose efforts have made this publication possible.

I wish the 12th UNI-IN ALLIANCE Undergraduate Research Symposium every success and hope that the discussions and research presented will inspire new ideas, collaborations, and solutions for a sustainable future.

Thank you.

Message from Snr. Prof. Upul Subasinghe
Dean
Faculty of Applied Sciences
University of Sri Jayewardenepura



It is with great pleasure that I extend my warm greetings to all participants, organisers, academic staff, industry partners, and distinguished guests of the **12th UNI-IN ALLIANCE Undergraduate Research Symposium 2026**. I am delighted to note that the Society of Industrial Scholars of the B.Sc. (Hons.) in Applied Sciences Degree Programme has once again taken the initiative to organise this important academic event, providing a valuable platform for undergraduate researchers to showcase their innovative ideas, research findings, and scholarly achievements.

The theme of this year's symposium, ***“Exploring Frontiers for a Closed-loop Future,”*** is both timely and significant. As the world increasingly seeks sustainable solutions to complex environmental, industrial, and societal challenges, the concept of a closed-loop future emphasises the importance of resource efficiency, innovation, circularity, and responsible stewardship. Through research and collaboration, our future scientists and professionals have a vital role to play in advancing these aspirations.

I commend the organising committee, academic coordinators, staff members, sponsors, and all contributors whose hard work and dedication have made this symposium a reality. The publication of these proceedings stands as a valuable record of the intellectual contributions made by our students and highlights the vibrant research culture fostered within the Faculty of Applied Sciences.

I trust that the knowledge shared through this symposium will inspire meaningful discussions, encourage interdisciplinary collaboration, and contribute to the development of innovative solutions for a more sustainable and resilient future.

Thank you.

Message from Prof. Chamari Dissanayake
Coordinator
B.Sc. (Honours) Degree in Applied Sciences
Faculty of Applied Sciences
University of Sri Jayewardenepura



It is with great pleasure that I extend my warmest greetings to all presenters, contributors, participants, and readers of the official proceedings of the **12th UNI-IN ALLIANCE Undergraduate Research Symposium**, organised by the Society of Industrial Scholars of the B.Sc. (Hons.) in Applied Sciences Degree Programme, Faculty of Applied Sciences, University of Sri Jayewardenepura.

This undergraduate research symposium has become a significant platform for showcasing the intellectual curiosity, innovation, and research excellence of our undergraduate scholars. This year's theme, ***"Exploring Frontiers for a Closed-loop Future,"*** reflects the growing global emphasis on sustainability, resource efficiency, circular economy principles, and the development of innovative solutions to address contemporary environmental, social, and industrial challenges.

The abstracts and research findings compiled in these proceedings demonstrate the dedication, creativity, and scientific rigour of our students. Their work spans diverse disciplines within applied sciences and highlights the critical role that research and innovation play in shaping a sustainable future. The symposium not only provides an opportunity for students to disseminate their research findings but also nurtures interdisciplinary collaboration, critical thinking, and professional development.

I commend all student researchers for their commitment and perseverance in conducting meaningful research. My sincere appreciation is also extended to the academic staff, supervisors, reviewers, organising committee members, and the Society of Industrial Scholars for their invaluable contributions in making this symposium a success.

I am confident that the research presented in this proceeding will inspire further inquiry, encourage innovative thinking, and contribute to the advancement of knowledge in support of a more sustainable and resilient future.

I congratulate all authors on their achievements and wish them continued success in their academic and professional endeavours.

Thank you.

Message from Dr. Dulan Jayasekara
Co-chairperson
UNI-IN ALLIANCE Undergraduate Research
Symposium 2026



It is my pleasure to extend my greetings to all those associated with the **12th UNI-IN ALLIANCE Undergraduate Research Symposium**, organised by the Society of Industrial Scholars of the B.Sc. (Hons.) in Applied Sciences Degree Programme, Faculty of Applied Sciences, University of Sri Jayewardenepura.

This symposium marks an important milestone in the academic journey of our students, providing a platform to showcase the outcomes of research, innovation, and practical learning. The abstracts presented in this proceedings volume reflect the dedication, curiosity, and scientific rigour of undergraduate researchers across a diverse range of disciplines within the applied sciences.

The theme of this year's symposium, ***"Exploring Frontiers for a Closed-loop Future"*** highlights the need for sustainable solutions that integrate scientific innovation, responsible resource use, and long-term societal well-being. As global challenges continue to evolve, interdisciplinary research and collaborative problem-solving are essential for building resilient and sustainable futures.

A distinctive strength of UNI-IN ALLIANCE 2026 is its strong emphasis on university–industry engagement. Through academic training and industry-based internships, our students gain valuable opportunities to apply scientific knowledge to real-world challenges while developing skills relevant to the needs of modern society and industry. Such partnerships foster innovation, enhance employability, and generate impactful research with practical applications.

Equally important is the cultivation of a strong research culture among young scientists. By engaging students in research early in their academic careers, we nurture critical thinking, creativity, and evidence-based decision-making, preparing future scientists and innovators to contribute meaningfully to national and global development.

I extend my sincere appreciation to all authors, supervisors, reviewers, industry partners, sponsors, and organising committee members whose dedication has made this symposium possible. I wish UNI-IN ALLIANCE 2026 every success and hope it will continue to inspire research excellence, innovation, and meaningful collaborations in the years ahead.

Thank you.

Message from Dr. Kanchana Dissanayake
Keynote Speaker
Associate Professor
University of Borås, Sweden



It is a great pleasure to be associated with the **12th UNI-IN ALLIANCE Undergraduate Research Symposium** and its timely theme, “*Exploring Frontiers for a Closed-loop Future.*” As we face increasing environmental and resource challenges, the transition toward a closed-loop systems offers a powerful pathway to sustainable development by transforming waste into value and designing systems that keep materials, products, and resources in continuous use.

The concept of closing resource loops challenges us to rethink how we produce, consume, and recover value. Rather than viewing resources as disposable, a circular approach recognises them as assets that should remain in productive use for as long as possible through reuse, repair, remanufacturing, and recycling. Achieving this vision requires innovation, interdisciplinary collaboration, and a willingness to redesign systems across industries and societies.

I commend the organisers and participants for fostering a culture of inquiry and innovation. The ideas generated through research today will help shape the solutions needed to create regenerative systems that operate within planetary boundaries while supporting economic prosperity and societal well-being.

I hope this symposium inspires participants to think beyond linear models and to explore how science, technology, and human ingenuity can contribute to closing resource loops and building a more resilient and sustainable future for generations to come.

Thank you.

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The organising committee of the 12th “UNI-IN ALLIANCE” Undergraduate Research Symposium 2026 would like to express our sincere gratitude to all individuals and groups whose guidance, commitment, and generous support made this event a remarkable success. The symposium represents a collective achievement, and we extend our sincere appreciation for the following contributions.

- Snr Prof. M.M.Pathmalal, Vice Chancellor of the University of Sri Jayewardenepura,
- Snr Prof. S.M.C.U.P. Subasinghe, Dean of the Faculty of Applied Sciences, University of Sri Jayewardenepura,
- Prof. D.C.T. Dissanayake, Coordinator of the B.Sc. (Honours) in Applied Sciences Degree Programme and the Senior Treasurer of the Society of Industrial Scholars (2025/26),
- Dr. E.G.D.P. Jayasekara, Symposium Co-Chair of the 12th UNI-IN ALLIANCE Undergraduate Research Symposium,
- Dr. A.D.I.K. Weeraratne, Editor-in-Chief, and Dr. K.N. Samarasekera, Editor, and the Editorial Board Members of the 12th UNI-IN ALLIANCE Undergraduate Research Symposium,
- Heads of the Departments of the Faculty of Applied Sciences,
- Department Coordinators of the B.Sc. (Honours) in Applied Sciences Degree Programme,
- All the Reviewers and Evaluators of the Symposium Sessions,
- Former Coordinator and former assistant coordinators of the B.Sc. (Honours) in Applied Sciences Degree Programme,
- Academic Staff of the Faculty of Applied Sciences,
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- Ms. W.W.G.V.R. Wijewickrama, Temporary Demonstrator of the B.Sc. (Honours) in Applied Sciences Degree Programme,
- Registrar, Bursar of the University of Sri Jayewardenepura,
- Senior Assistant Registrar, Senior Assistant Bursar, and all the Staff of the Office of the Dean, FAS,
- President, Mr. S.A.M.N.P.M. Alagiyawanna, Secretary, Ms. W.S.P. De Silva, Junior Treasurer, Ms. R.A.G.S.P. Rupasinghe, and all the office bearers and members of the Society of Industrial Scholars for the year 2025/26,
- Symposium Co-Chair, Mr. K.M.D.D. Eranga, Symposium Secretary, Ms. H.A.L.S. Wijepala, and all the members of the subcommittee of the 12th UNI-IN ALLIANCE Undergraduate Research Symposium 2026,
- The generous Support and the dedicated efforts of J’pura Media in providing excellent media coverage,
- Senior students from previous batches and the junior students of the B.Sc. (Honours) Degree in Applied Sciences,
- Non-academic staff members of the Faculty of Applied Sciences.

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AGENDA

**The 12th Consecutive Annual Undergraduate Research Symposium
“UNI-IN ALLIANCE 2026”**

03rd July 2026

At the Senate Board Room, USJ (8.00 – 10.30 am)

08:00 - 08:30 am	Registration
08:30 - 08:40 am	Lighting of the Oil Lamp and University Anthem
08:40 - 08:45 am	Welcome Address by Dr. E.G.D.P Jayasekara, Co-chairperson of the symposium
08:45 - 08:50 am	Theme Presentation
08:50 - 08:55 am	Address by Senior Prof. S.M.C.U.P Subasinghe, Dean, Faculty of Applied Sciences, USJ
08:55 - 09:00 am	Address by Senior Prof. Pathmalal M. Manage, Vice Chancellor of USJ
09:00 - 09:10 am	Video Presentation (Introduction)
09:10 - 09:30 am	Keynote Speech by Dr. Kanchana Dissanayake, Associate Professor, University of Borås, Sweden
09:30 - 09:40 am	Distribution of Symposium Proceedings
09:40 - 09:50 am	Presentation of Tokens of Appreciation
09:50 - 10.00 am	Vote of Thanks by Mr. Dulan Eranga, Co-chairperson of the symposium
10:00 - 10:05 am	Official Photograph Session
10:05 - 10:30 am	Refreshments

At the Faculty Premises, FAS (10.30 am – 2.30 pm)

10.30 - 2.30 pm	Technical Sessions
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At the Botany Auditorium, FAS (3.15 pm – 4.15 pm)

3.15 - 3.25 pm	Address by Prof. D.C.T. Dissanayake, Coordinator, B.Sc. (Hons.) in Applied Sciences Degree Programme
3.25 - 3.30 pm	Address by Dr. A.D.K.I. Weeraratne, Editor-in-Chief, 12 th UNI-IN ALLIANCE Undergraduate Research Symposium
3.30 - 4.05 pm	Awarding Ceremony
4.05 - 4.10 pm	Concluding Remarks and Vote of Thanks by Ms. H.A.L.S. Wijepala, Symposium Secretary
4.10 - 4.15 pm	National Anthem



BIOLOGICAL SCIENCES

IN-SILICO DESIGN AND COMPUTATIONAL VALIDATION OF A DUAL-BIOMARKER CRISPR/DCAS9-BASED SYNTHETIC GENETIC AND-GATE CIRCUIT FOR EPILEPSY DETECTION

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Epilepsy is a complex human neurological condition resulting from the alteration of the brain's electrical activity and associated with brain damage. It is characterised by recurrent, unprovoked seizures and is currently diagnosed using electrophysiological and imaging techniques. The inability of such techniques to distinguish single provoked seizures from chronic epilepsy highlights the need for an epilepsy-specific biochemical diagnostic method implementing multiple concurrent molecular signals. This study aimed to computationally design and validate a programmable synthetic genetic circuit capable of detecting epilepsy-associated postictal biomarker signatures. The AND-gate logic was implemented in the circuit targeting a human brain-derived cell line. Upon exposure to postictal patient blood samples, simultaneous elevation of lactate and prolactin is predicted to trigger the expression of the fluorescent NanoLuc reporter. The multilayered circuit combines CRISPR/dCas9-mediated transcriptional regulation with split-protease-mediated repression relief. The guide RNA sequences and a synthetic repressor were designed as parts of the genetic circuit and were incorporated into multiple gene cassettes. Validation of the circuit was performed through deterministic simulations, protein structural modelling, and molecular docking analyses. A plausible three-dimensional architecture of the synthetic repressor was obtained through in silico protein folding. Structural evaluation identified the K82 split variant of HRV-3C protease as the most suitable regulatory protease, with the best catalytic geometry and docking characteristics consistent with plausible substrate recognition and cleavage. Further optimisation of the gene sequence architecture improved the confidence of the domain-level structures. According to the deterministic simulation results, reporter activation occurred only when both biomarkers were simultaneously elevated, whereas individual inputs failed to induce output expression, confirming the expected AND-gate behaviour. Overall, these findings demonstrate the feasibility, specificity, and modularity of the proposed genetic circuit for epilepsy detection. The study provides a robust computational framework for the future development of cell-based diagnostic systems for epilepsy.

Keywords: Genetic circuit, Epilepsy, Seizures, Diagnostic, Specificity

ANTIBACTERIAL POTENTIAL OF AQUEOUS AND METHANOLIC EXTRACTS OF *Entada rheedei* BARK AGAINST SELECTED BACTERIA

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E. rheedei, a medicinal plant belonging to the family Fabaceae, has traditionally been used in indigenous medicinal systems for the treatment of wounds and infections. Despite its extensive ethnomedicinal applications, scientific validation of its antibacterial potential remains limited, particularly in the Sri Lankan context and this study investigated the antibacterial potential of its bark. Bark samples were collected, shade-dried, and ground into a coarse powder prior to extraction. Ultrasound-assisted extraction was performed using distilled water and methanol as solvents. The aqueous extract was freeze-dried using a freeze dryer to obtain the crude extract, whereas the methanolic extract was concentrated using a rotary evaporator. The antibacterial activity was studied against control strains of methicillin-resistant *Staphylococcus aureus* (MRSA, ATCC 43300), methicillin-sensitive *Staphylococcus aureus* (MSSA, ATCC 25923), *Escherichia coli* (ATCC 25922), and *Pseudomonas aeruginosa* (ATCC 27853). Antibacterial screening was conducted using the agar well diffusion method with extract concentration series ranging from 1–8 mg/mL, while the minimum inhibitory concentration (MIC) was determined using the agar dilution method with concentrations ranging from 0.1–3.2 mg/mL. Both extracts showed concentration-dependent antibacterial activity against MSSA, MRSA, and *E. coli*. The aqueous bark extract showed zone of inhibition (ZOI) against MSSA: 10.33 ± 0.58 , 12.00 ± 0.00 , 13.33 ± 0.58 , and 16.00 ± 0.00 mm at 1, 2, 4, and 8 mg/mL, respectively. MRSA showed ZOI values of 11.33 ± 0.58 , 13.00 ± 0.00 , and 14.67 ± 0.58 mm, while *E. coli* showed ZOI values of 12.00 ± 0.00 , 13.00 ± 0.00 , and 15.67 ± 0.58 mm at 2, 4, and 8 mg/mL, respectively. No inhibition was observed at 1 mg/mL for MRSA and *E. coli*. The methanolic bark extract showed ZOI values against MRSA of 11.00 ± 0.00 , 12.33 ± 0.58 , and 15.33 ± 0.58 mm; against MSSA of 11.33 ± 0.58 , 14.67 ± 0.58 , and 17.33 ± 0.58 mm; and against *E. coli* of 10.00 ± 0.00 , 12.00 ± 0.00 , 13.33 ± 0.58 , and 15.00 ± 0.00 mm at 1, 2, 4, and 8 mg/mL, respectively. No inhibition was observed at 1 mg/mL for MRSA and MSSA. No inhibitory activity was observed against *P. aeruginosa* for either extract. The MIC of aqueous extract was 0.4 mg/mL against MRSA, MSSA, and *E. coli*. The MIC of methanolic extract was 0.8 mg/mL against MSSA and 1.6 mg/mL against both MRSA and *E. coli*. Aqueous extract showed highest antibacterial activity compared to the methanolic extract. The study concludes that both extracts of *E. rheedei* bark possess antibacterial activity, with the aqueous extract showing particularly promising effects against MRSA, MSSA, and *E. coli*. These findings support its traditional medicinal insight in wound-related infections. Further studies are warranted to evaluate its activity against a broader spectrum of microorganisms, including multidrug-resistant human pathogens.

Keywords: *Entada rheedei*, Ultrasound-assisted extraction, Antibacterial

PHYTOCHEMICAL SCREENING AND ANTIBACTERIAL ACTIVITY OF METHANOLIC EXTRACTS OF LEAF AND ROOT OF *Solanum torvum* Sw

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Medicinal plants are rich and diverse sources of phytochemicals with antibacterial properties, especially in the context of rising antibiotic resistance. *Solanum torvum* Sw. belongs to the family SOLANACEAE and it has long been utilised in many countries to treat infections and inflammatory conditions. However, there is limited scientific evidence of its antibacterial potential, especially from Sri Lankan accessions. This study aimed to investigate the phytochemical composition and antibacterial activity of methanolic leaf and root extracts of locally collected *S. torvum*. Methanolic extracts were prepared from coarse-powdered leaves and roots using ultrasound-assisted extraction (UAE). Qualitative preliminary phytochemical screening was conducted. Antibacterial activity; screening was performed using the agar well diffusion method and minimum inhibitory concentrations (MIC) was determined using the agar dilution method, against control strains of methicillin-sensitive *Staphylococcus aureus* (MSSA), methicillin-resistant *Staphylococcus aureus* (MRSA), *Escherichia coli*, and *Pseudomonas aeruginosa*. Phytochemical screening revealed the presence of flavonoids, terpenoids, and phenolics in both leaf and root extracts. In contrast, alkaloids were unique to the leaves, and saponins were completely absent in both leaf and root extracts. The methanolic root extracts exhibited antimicrobial activity with MIC values of 0.8 mg/mL against MRSA, 1.6 mg/mL against MSSA, and 3.2 mg/mL against *E. coli*, while MIC value against *P. aeruginosa* exceeded 3.2 mg/mL. In contrast, the methanolic leaf extract showed MIC values of 12.8 mg/mL against MSSA, while MIC values against MRSA, *E. coli*, and *P. aeruginosa* exceeded 12.8 mg/mL. These findings indicate that methanolic root extracts of *S. torvum* exhibit greater antibacterial potency than leaf extracts, particularly against *S. aureus* strains. The observed activity may be attributed to the presence of bioactive phytochemicals such as flavonoids and phenolics, which are known for antibacterial potential. In conclusion, the root extracts of *S. torvum* demonstrate promising antibacterial potential and may contribute to mitigating antimicrobial resistance. Further studies are recommended to test the antimicrobial activity with spectrum of organisms and evaluate their mechanisms of action.

Keywords: Antibacterial activity, *Solanum torvum*, Phytochemical screening, Methanolic extract, Minimum inhibitory concentrations (MIC)

MOLECULAR AND PHENOTYPIC SCREENING OF SELECTED *Capsicum* VARIETIES FOR ANTHRACNOSE RESISTANCE CAUSED BY *Colletotrichum capsici*

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Anthrachnose caused by *Colletotrichum capsici* is one of the major fungal diseases affecting *Capsicum* cultivation in Sri Lanka. The disease causes significant losses in crop yield and adversely affects fruit quality. Although chemical control is commonly used, continuous fungicide application raises environmental concerns and adds to production costs for farmers. Thus, it is important to identify resistant varieties for sustainable disease management and breeding programmes. The present study was conducted to identify anthracnose-resistant varieties of *Capsicum* through molecular markers and phenotypic screening. Four varieties of *Capsicum* used in the study were Heen kochchi (*Capsicum frutescens* L.), Sudu kochchi (*Capsicum frutescens* L.), *Capsicum baccatum*, and Bataluang miris (*Capsicum annuum* L.). Genomic DNA was extracted by the CTAB method. Two SSR markers (HpmsE032, HpmsE143) and one SCAR marker (P5), linked to anthracnose-resistant loci, were used for PCR amplification. The PCR products were subjected to agarose gel electrophoresis (4%) to identify polymorphic banding patterns. Phenotypic screening was done by artificial inoculation of disease-free mature green fruits (35-40 days after flowering) with *C. capsici* using the mycelial plug method. Disease severity percentage was determined by the ratio of lesion area around the inoculation site, relative to the total fruit area. Amplified products were obtained for SSR markers HpmsE032 and HpmsE143 in all evaluated *Capsicum* varieties; but due to limited resolution of the 4% agarose gel, resistant and susceptible alleles could not be conclusively differentiated. *Capsicum baccatum* showed the lowest disease severity (0.0556%), which suggests a higher resistance level than the other varieties. Bataluang miris also had a low disease severity (0.177%). In contrast, the disease severity percentages for Heen kochchi and Sudu kochchi were high (24.38% and 21.20%, respectively), indicating they are highly susceptible to *C. capsici*. Although susceptible varieties like Sudu kochchi and Heen kochchi showed resistance-associated bands with the SCAR marker P5, the marker results were not consistent with the phenotypic disease response. This result suggested a limited reliability of this marker in different genetic backgrounds. The findings highlight the need for using molecular markers along with phenotypic screening to identify resistant genotypes for *Capsicum* breeding programmes in Sri Lanka.

Keywords: Anthracnose, *Capsicum*, Molecular markers.

EXTRACTION, CHARACTERISATION, AND EVALUATION OF ANTIFUNGAL ACTIVITY OF SECONDARY METABOLITES OF *Trichoderma asperellum* AGAINST SELECTED PLANT PATHOGENIC FUNGI

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Plant fungal diseases cause a significant threat to agriculture, affecting crop health, yield, and quality. Synthetic chemical fungicides are widely used for disease management, however their adverse effect on environment and human health highlight the need for sustainable and eco-friendly alternatives. Species of the genus *Trichoderma* have been widely recognised as effective biological control agents due to their broad-spectrum antagonistic activity against a diverse range of plant pathogens. This study evaluated the antifungal activity of metabolites produced by *T. asperellum* strain CCTCC AW318 against the plant pathogenic fungi *Curvularia lunata*, *Colletotrichum siamense*, and *Fusarium suttonianum*. The antagonistic potential of *T. asperellum* was assessed using dual culture and volatile compounds assays against the selected phytopathogenic fungi. Production of secondary metabolites of *T. asperellum* was facilitated by submerged fermentation in Potato Dextrose Broth (PDB), followed by extraction using ethyl acetate. The chemical composition of the extract was characterised using phytochemical analysis, Thin-Layer Chromatography (TLC) and Gas Chromatography-Mass Spectrometry (GC-MS). Antifungal activity was determined at different concentrations (1-1000 µg/mL) of the extract using poisoned food technique. In the dual culture assay, *T. asperellum* showed inhibition against all tested fungi, with the highest inhibition against *C. siamense* (65.84%), followed by *C. lunata* (63.11%), and *F. suttonianum* (53.81%). The volatile compound assay exhibited inhibitory activity against *C. lunata*, *C. siamense*, and *F. suttonianum*, with inhibition percentage of 20.72%, 51.76%, and 25.68%, respectively. Phytochemical analysis indicated a presence of alkaloids, phenols, tannins, flavonoids, and sterols. TLC assay detected 11 distinct spots, with corresponding R_f values ranging from 0.16 to 0.97. GC-MS analysis showed 23 volatile and semi-volatile chemical constituents. Among them, 11 compounds were identified as the antifungal secondary metabolites such as dodecane (3.81%), 1-tetradecene (9.70%), butylated hydroxytoluene (9.70%), and isopropyl myristate (1.37%). The inhibitory effect of the fungal extract increased with concentration, indicating a concentration-dependent response. *F. suttonianum* showed higher sensitivity compared to *C. lunata* and *C. siamense*. At the 1000 µg/mL, *F. suttonianum* exhibited the greatest inhibition (40.72%), followed by *C. lunata* (22.54%) and *C. siamense* (21.00%). In conclusion, the findings of this study demonstrate that the secondary metabolites produced by *T. asperellum* possess antifungal activity against *C. lunata*, *C. siamense*, and *F. suttonianum*, showing its strong potential as environmentally friendly biocontrol agent for managing plant fungal diseases.

Keywords: GC-MS, Phytochemical analysis, Poisoned food technique, Secondary metabolites, *Trichoderma*

ISOLATION, IDENTIFICATION AND CHARACTERISATION OF *Talaromyces pinophilus* AS A BIOCONTROL AGENT AGAINST BEAN ANTHRACNOSE CAUSED BY *Colletotrichum lindemuthianum*

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Bean anthracnose, caused by the hemibiotrophic fungus *Colletotrichum lindemuthianum* (Sacc. & Magnus) is recognised as one of the most destructive seed borne disease of common bean (*Phaseolus vulgaris* L.). Current management practices depend on chemical fungicides and resistant varieties, but studies exploring biocontrol agents to suppress *C. lindemuthianum* are limited in Sri Lanka. This study aimed to isolate, identify, and characterise effective fungal biocontrol agents from the bean rhizosphere against *C. lindemuthianum*. A pure culture of *C. lindemuthianum* (SUB 16130661) was obtained from the Horticultural Crop Research and Development Institute (HORDI), Gannoruwa, Sri Lanka. Its pathogenicity was confirmed using Koch's postulates on healthy bean pods. Rhizosphere soil samples were collected from *P. vulgaris* plants at the HORDI research field and fungi were isolated by spread plating serial dilutions onto potato dextrose agar (PDA). Antagonistic activity of all isolates against *C. lindemuthianum* was assessed using dual culture plate assays and the percentage inhibition of radial growth (PIRG) was calculated. Mycoparasitic interactions were examined microscopically using the slide culture method. The isolate showing the highest PIRG was selected and its DNA was extracted using the Cetyltrimethylammonium Bromide (CTAB) method. Subsequently, PCR amplification was performed using ITS-1 (5' TCCGTAGGTGAACCTGCGG 3') and ITS-4 (5' TCCTCCGCTTATTGATATGC 3'). The resulting ITS sequences were compared against reference sequences in the NCBI GenBank database using the BLAST algorithm to confirm species identity. Pathogenicity of *C. lindemuthianum* was successfully confirmed following Koch's postulates. A total of seventeen (17) fungal isolates were collected from bean rhizosphere soil samples. Among the isolates, five exhibited more than 50% PIRG values. These five isolates exhibited distinct coiling and looping hyphal structures around the pathogen hyphae indicating mycoparasitism. The isolate designated as BR03 exhibited the highest PIRG value and its PCR product produced a band at approximately 500-600 bp on agarose gel electrophoresis. BLAST analysis of NCBI GenBank sequences with 100% query coverage identified the isolate as *Talaromyces pinophilus*. The identification represents a significant discovery of a locally adapted, novel biocontrol agent. Further studies under greenhouse and field conditions using different environmental conditions and bean varieties are needed to evaluate its effectiveness.

Keywords: Antagonistic activity, Biological control, Dual culture assay, Mycoparasitism, Percentage inhibition of radial growth (PIRG).

CATCH RATES AND POPULATION DYNAMICS OF *Metapenaeus dobsoni* OFF NEGOMBO, SRI LANKA

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Penaeid shrimps are among the most commercially important fishery resources in tropical and subtropical coastal waters due to their high economic value and market demand. Among them, *Metapenaeus dobsoni* is one of the major commercial shrimp species in the trawl fishery. This study assessed the status of the non-mechanised shrimp trawl fishery operated off Negombo, Sri Lanka with special emphasis on fishery and population parameters of *M. dobsoni* after a decade since last assessment. Catch, effort, and morphometric data were collected through fortnightly field visits to the Negombo fish landing sites from June 2025 to May 2026. On each sampling day, 50–60% of the non-mechanised trawls were sampled. Three random samples of *M. dobsoni* (approximately 0.5 kg each) were collected from trawl catches, while an additional 1.0 kg sample landed by stake seine nets was purchased from fish vendors. Catch composition, seasonal variations in catch rates, shrimp and by-catch production were estimated. Additionally morphometric and population parameters of *M. dobsoni* were analysed. Population parameters were estimated using the “TropFishR” package with the ELEFAN_GA approach. Six shrimp species were identified in the trawl catches, with *M. dobsoni* contributing the highest proportion (53%), followed by *Parapenaeopsis coromandelica* (27%). Seasonal variations in fishing effort were evident, with the highest effort recorded in October (2850 trawl hours) and the lowest in July (750 trawl hours). The average shrimp Catch Per Unit Effort (CPUE) was 1.57 kg boat⁻¹ hr⁻¹ and it was 1.02 kg boat⁻¹ hr⁻¹ for by-catch. Females showed larger body size (9.11 cm) and greater body weight (5.13 g) than males (7.86 cm and 3.03 g, respectively; $p > 0.05$), and the sex ratio significantly deviated from the expected 1:1 ratio. Length–weight analysis indicated isometric growth in females ($b = 3.087$) and negative allometric growth in males ($b = 2.866$) while pool data indicate isometric growth ($b = 3.081$). Growth and mortality parameters of *M. dobsoni* were estimated as $L_{\infty} = 12.49$ cm, $K = 2.12$ yr⁻¹, $Z = 10.34$ yr⁻¹, $M = 3.10$ yr⁻¹, and $F = 7.24$ yr⁻¹. The current exploitation rate ($E_{\text{curr}} = 0.70$) exceeded the maximum sustainable level ($E_{\text{max}} = 5$), indicating overexploitation status. The present study provides updated baseline information on the fishery and population dynamics of *M. dobsoni* off Negombo Sri Lanka and will be useful for future stock assessments and management of the artisanal shrimp trawl fishery in Sri Lanka.

Keywords: Penaeid shrimps, Population dynamics, Non-mechanised trawl fishery, Seine fishery, Stock assessment

PHYTOCHEMICAL ANALYSIS AND ANTIBACTERIAL POTENTIAL OF TWO VARIETIES OF *Polyscias scutellaria* (KÖPPA KOLA) LEAVES AGAINST SELECTED PATHOGENIC BACTERIA

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Medicinal plants have been recognised as valuable sources of bioactive compounds with significant therapeutic potential, including antimicrobial substances. *Polyscias scutellaria*, locally known as köppa kola, is a medicinal plant that is used to treat microbial infections, wounds, urinary tract diseases and inflammations. Despite its widespread traditional medical use, adequate scientific validation of the antimicrobial properties remains limited in Sri Lanka. This study aimed to evaluate and compare the antibacterial activity against selected bacteria and analyse the phytochemical profile of the two varieties of *P. scutellaria* leaf extracts. The plant samples of both varieties were authenticated at the National Herbarium, Royal Botanical Gardens, Peradeniya, Sri Lanka. The leaves were shade-dried, pulverised into coarse powder and extracted using sterilised distilled water and methanol. Alkaloids, flavonoids, phenolic compounds, saponins and terpenoids were analysed using standard methods. The antibacterial activity of the extracts was evaluated against control strains of methicillin-sensitive *Staphylococcus aureus* (MSSA), methicillin-resistant *Staphylococcus aureus* (MRSA), *Escherichia coli* and *Pseudomonas aeruginosa*. Zone of inhibition (ZOI) was determined using agar well diffusion method, and agar dilution method was used to evaluate Minimum Inhibitory Concentration (MIC). Phytochemical analysis revealed the presence of alkaloids, flavonoids, saponins, terpenoids and phenolic compounds in both varieties. Aqueous extracts of both varieties did not produce any ZOI against any tested bacteria. Methanol extracts of both varieties demonstrated inhibition against *P. aeruginosa* across all tested concentrations (1, 2, 4 and 8 mg/mL). At 8 mg/mL, variety 2 produced larger zones (30.00 ± 02.00 mm) than variety 1 (28.33 ± 00.58 mm). No ZOI were observed against MSSA, MRSA and *E. coli* with methanol extracts of either variety. MIC of aqueous extracts was above 6.4 mg/mL against all tested bacteria. For methanol extracts, MIC against *P. aeruginosa* was 6.4 mg/mL for variety 1 and 1.6 mg/mL for variety 2. MIC against MSSA was 3.2 mg/mL for variety 1 and 6.4 mg/mL for variety 2. These findings demonstrate that *P. scutellaria* leaf extracts possess selective antibacterial activity, particularly the methanol extract of variety 2 against *P. aeruginosa*. This study provides preliminary scientific support for the traditional use of *P. scutellaria* in treating bacterial infections.

Keywords: Agar well diffusion, Antibacterial activity, MIC, Phytochemical, *Polyscias scutellaria*

PHENOLIC-RICH METHANOL ENDEMIC BARK EXTRACT EXHIBITS POTENT ANTIOXIDANT AND ANTI-INFLAMMATORY ACTIVITIES

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Sri Lanka is blessed with rich biodiversity and a large number of endemic plant species. Although ancient Sri Lankan medicinal systems note that certain endemic plants possess significant pharmacological potential, many of these claims have not yet been scientifically investigated or experimentally validated. *Semecarpus coriaceus* Thwaites (Family: Anacardiaceae), a species endemic to Sri Lanka, has been traditionally valued in Sri Lankan indigenous medicine and Ayurveda for its wide range of medicinal properties. Therefore, the present study was aimed at evaluating the total phenolic content (TPC), antioxidant and anti-inflammatory activities of *Semecarpus coriaceus* Thwaites. The dried bark of *Semecarpus coriaceus* Thwaites was extracted with methanol by maceration. Total phenolic content (TPC) was determined using the Folin–Ciocalteu method, while antioxidant activity was measured using the 2,2-diphenyl-1 picrylhydrazyl (DPPH) radical scavenging assay. The anti-inflammatory activity was assessed using the human red blood cell (HRBC) stabilisation assay. All assays were conducted independently in triplicate (n = 3 biological replicates). Probability values were calculated by Student's t-test using GraphPad Prism 8.0 software. The TPC of the methanol bark extract was determined to be 93.36 ± 0.96 mg GAE/g extract. Notably, the extract exhibited a lower IC₅₀ value (0.033 mg/mL) than its standard, butylated hydroxytoluene (BHT) (0.178 mg/mL), suggesting that the extract possesses stronger DPPH radical-scavenging activity than the standard. However, the difference between the plant extract and the standard inhibition values observed in DPPH radical-scavenging activity at 1mg/mL was not statistically significant ($p > 0.05$). Furthermore, the extract demonstrated HRBC membrane stabilisation with an IC₅₀ value of 0.054 mg/mL, which was similar to that of its standard aspirin (0.055 mg/mL). The difference between the plant extract and the standard inhibition values observed in HRBC membrane stabilisation activity at 1mg/mL was statistically significant ($p < 0.05$). The study suggests that phenolic compounds present in the methanol extract of *Semecarpus coriaceus* Thwaites may contribute to its observed antioxidant and anti-inflammatory activities, together with other bioactive constituents.

Keywords: Total phenolic content, Antioxidant activity, Anti-inflammatory activity, Endemic plants of Sri Lanka, Natural products

DEVELOPMENT OF ALTERNATIVE CULTURE MEDIA FOR FUNGAL GROWTH USING LOCALLY AVAILABLE STARCH-RICH SUBSTRATES

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Conventional mycological research mainly relies on Potato Dextrose Agar (PDA), which is imported and costly for developing countries such as Sri Lanka. This creates significant economic barriers when conducting microbiological research and education. In addition to potatoes, several locally available starch-rich crops and agricultural residues remain underutilised despite their potential application in microbiological media preparation. Using these sustainable options reduces dependence on a single raw material source for media preparation as cost of potatoes may vary seasonally. Therefore, this study aims to identify sustainable local alternatives to PDA by evaluating locally available starch-rich substrates. Chickpea (*Cicer arietinum*), jackfruit seeds (*Artocarpus heterophyllus*), Habarala (*Alocasia* sp.), and pumpkin (*Curcubita* sp.) were selected based on their availability and starch content. The selected substrates were boiled to obtain aqueous extracts, which were supplemented with 1.5% w/v agar and sterilised before solidification. Commercial PDA served as the reference medium. A comparative performance analysis was conducted by inoculating the prepared alternative media and commercial PDA with *Trichoderma* sp. Fungal growth in each medium was quantified by measuring the radial colony diameter at 12-hour intervals to evaluate growth rates and reproductive ability across media compared to commercial PDA. *Trichoderma* sp. exhibited consistent growth on all tested media. Mean growth values recorded for PDA, Chickpea, Jackfruit seed, Habarala, and Pumpkin media were 3.344, 3.433, 3.189, 3.089, and 3.233. Statistical analysis revealed no significant differences among the tested media and PDA (ANOVA: $F=0.144$, $p=0.965$), demonstrating that all tested formulations were capable of supporting fungal growth under the experimental conditions. These findings demonstrate the potential of locally available starch-rich substrates as alternative culture media for fungal cultivation. The use of such substrates promotes the sustainable utilisation of locally available agricultural resources while providing additional options for culture media preparation. Further studies are required to validate these formulations with a wide range of fungal species and other microorganisms and to explore the development of powdered formulations for broader laboratory applications.

Keywords: PDA alternatives, Alternative culture media, Fungal cultivation, Sustainability, *Trichoderma*

A PRELIMINARY STUDY ON THE INCIDENCE OF *Bacillus cereus* GROUP IN READY-TO-EAT RICE PACKETS IN NUGEGODA, SRI LANKA

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Ready-to-eat (RTE) rice packets are high-risk foods for *Bacillus cereus* contamination due to the ability of its spores to survive cooking temperatures and multiply during improper storage conditions. Despite the widespread consumption of RTE rice products in Sri Lanka, limited published data are available regarding *B. cereus* contamination. This lack of local microbiological surveillance data may hinder effective assessment of potential food safety risks associated with cooked rice products commonly consumed by the public. The main objective of this study was to determine the incidence of *B. cereus* group in RTE rice samples collected from Nugegoda, Sri Lanka. A preliminary cross-sectional study was conducted and a total of 60 RTE rice samples were collected from street vendors and fixed food outlets over a period of 10 weeks using simple random sampling. Samples were transported to the laboratory in a cool box at 4 °C ± 1 °C and analysed within 2-3 h of collection. The isolation and enumeration of *B. cereus* group were carried out according to ISO 7932:2004 standards, using polymyxin egg yolk mannitol bromothymol blue agar (PEMBA) as the selective medium. Presumptive isolates were confirmed by haemolysis reaction on 5% sheep blood agar and Gram staining. Results were recorded as colony forming units per gram (CFU/g). Out of the 60 RTE rice samples analysed, 17 samples (28.3%) contained <10³ CFU/g and were classified as satisfactory according to the microbiological guidelines for RTE foods of the United Kingdom Health Security Agency (UKHSA). Fourteen samples (23.3%) had counts between 10³ and ≤10⁵ CFU/g and were classified as borderline. The majority, comprising 29 samples (48.3%) had counts >10⁵ CFU/g and were classified as unsatisfactory for human consumption. The findings of this study revealed significant food safety concerns associated with RTE rice packets sold in the study area. This suggests possible issues that can be related to improper handling, storage, and temperature control practices during food preparation and post-cooking handling process. The study emphasises the importance of implementing proper hygienic practices and regular microbiological monitoring to reduce contamination risks. The findings of the study may serve as baseline data to facilitate future comprehensive food safety surveillance studies on *B. cereus* contamination in RTE foods in the local context.

Keywords: *Bacillus*, Food safety, Ready-to-eat foods, Foodborne illness, Heat-resistant spores

CHLOROPLAST *matK* GENE- BASED MOLECULAR IDENTIFICATION OF LOCAL PUMPKIN VARIETIES IN SRI LANKA

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Pumpkin is an underutilised vegetable crop in the family Cucurbitaceae, and local varieties exhibit considerable morphological diversity. However, the molecular characterisation of Sri Lankan pumpkin varieties remains undocumented. This study aimed to predict the genetic relationships of selected local pumpkin varieties using chloroplast DNA sequence data. Young leaf samples of eight local varieties, Raja, Moragollagama, Suprema, and Lara (morphologically assigned to *Cucurbita maxima*), and Malbaro, Meemini, Hanoi, and Malbaro CIC (assigned to *Cucurbita moschata*), were collected from Dambulla, Sri Lanka. Genomic DNA was extracted using a modified CTAB method, and the chloroplast maturase K (*matK*) region was amplified by PCR, verified by agarose gel electrophoresis, and subjected to Sanger sequencing. Sequence data were aligned using MEGA 12, and a phylogenetic tree was constructed by maximum-likelihood inference with 500 bootstrap replicates. The phylogenetic tree based on *matK* sequences placed all Sri Lankan pumpkin samples within the *Cucurbita* clade and clearly separated them from the related genera *Citrullus* and *Cucumis*. Within the *Cucurbita* group, the Sri Lankan accessions formed a single, closely related cluster. Raja and Malbaro grouped with strong bootstrap support, whereas the other local varieties appeared on nearly all branches with weaker support. This pattern suggests that Raja and Malbaro may share the same or very closely related maternal lineage, even though their morphological characters place them in different cultivated species. This prediction is consistent with a scenario of past interspecific hybridisation between these species. The study provides the first DNA-based evidence for the identities and relationships of the selected local pumpkin varieties and shows that more samples and additional genetic data are needed to fully confirm these predicted relationships and guide future pumpkin conservation and breeding efforts.

Keywords: Pumpkin, *Cucurbita*, *matK*, Molecular identification, Phylogenetic tree

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EXPLORING THE DETERMINANTS OF THE ACCEPTANCE OF CURRENT GENERATION TO PURSUE THE AUTHENTIC MASKS AND PUPPETRY INDUSTRY IN AMBALANGODA, SRI LANKA

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Nowadays authentic masks and puppetry industry has faced huge decline due to several reasons such as reducing intergenerational knowledge, reduced public interest and modernisation. Despite its cultural importance, limited research has examined the acceptance of current generation to pursue in this industry. Therefore, the primary purpose of the study was to explore whether current generation accept to pursue the industry and identify the determinants of the acceptance of current generation to pursue the authentic masks and puppetry industry. At the same time study was designed to identify key reasons to industry declining. A mixed method approach was used in the study. A non-probability convenience sampling, purposive sampling and snow ball sampling methods were used to collect data. Quantitative data was collected from 33 respondents while qualitative data was collected from 11 respondents. The results revealed that current generation's acceptance of pursue the industry is moderate and uncertain regarding future involvement. Most influencing factor is knowledge transmission but financial challenges, future anxiety and marketing channels also showed a significant relationship. It is identified unstable income, lack of institutional support, limited market access and effects of alternative career paths as major reasons for the declining of the industry. Overall, the industry remains in a vulnerable stage and it is holding potential to revival of the industry. So future researchers are encouraged to expand the study in other regions where masks and puppetry industry exists. From studying different regions, it is able to do comparative analysis and provide wider understanding how the industry shows variations across different regions in Sri Lanka. The findings provide guidance for policymakers, industry stakeholders to develop strategies for revival and sustain the authentic masks and puppetry industry in Ambalangoda, Sri Lanka.

Keywords: *Acceptance, Authentic masks, Puppetry, Decline, Cultural heritage*

EXPLORING THE FACTORS AFFECTING CONSUMER BEHAVIOUR TOWARD ECO-FRIENDLY PRODUCTS: THE ROLE OF PERCEPTION OF THE GREEN ACTIVITY TRAP AMONG CONSUMERS IN SRI LANKA

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Environmental degradation and growing uncertainty regarding corporate sustainability claims have highlighted the need to better understand consumer behaviour toward eco-friendly products. Although eco-friendly consumption has gained attention in recent years, consumers are increasingly exposed to various green marketing practices that may influence their behaviour toward eco-friendly products either positively or negatively. In particular, limited research has focused on the concept of the "Green Activity Trap", which refers to organisations engage in symbolic or superficial environmental activities rather than genuinely impactful sustainability practices. This study was supported by several theories like Theory of Planned Behaviour (TPB), Signaling Theory, Attribution Theory, and Value-Belief-Norm (VBN) Theory. The objective of this study is to examine the effect of greenwashing exposure, perceived message inconsistency, lack of transparency, perceived lack of impact, eco-fatigue and environmental skepticism on consumer behaviour toward eco-friendly products and also to examine the relationship between the perception of the green activity trap and consumer behaviour. A quantitative research design was used. The target population consisted of consumers who purchase or are aware of eco-friendly products in Sri Lanka. A non-probability convenience sampling technique was used, and data were collected from 252 respondents using a structured questionnaire with a five-point Likert scale. The collected data were analysed using SPSS through descriptive statistics, Pearson correlation analysis and multiple regression analysis. The regression model was statistically significant and had a strong explanatory power which explains that 78.6% of the variation in consumer behaviour toward eco-friendly products. Greenwashing exposure, environmental skepticism and lack of transparency had a significant positive effect on consumer behaviour toward eco-friendly products. Greenwashing exposure was the most influential predictor. In contrast, eco-fatigue had a negative and significant effect. Perceived message inconsistency and perceived lack of impact were not statistically significant. Furthermore, a significant relationship was identified between the perception of the green activity trap and consumer behaviour toward eco-friendly products. The findings suggest that exposure to environmental claims can increase consumer awareness encourage more informed purchasing decisions, while excessive and repetitive sustainability messaging may lead to consumer fatigue and reduced engagement. The study provides practical implications for organisations by emphasising the importance of authentic sustainability practices, transparent communication, and credible environmental marketing strategies to promote positive consumer behaviour toward eco-friendly products.

Keywords: *Green activity trap, Consumer behaviour, Eco-friendly products, Greenwashing exposure, Environmental scepticism*

UNDERSTANDING REPURCHASE INTENTION AFTER SERVICE FAILURE: THE MEDIATING EFFECT OF E-COMMERCE SERVICE TOLERANCE IN SRI LANKA

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The rapid expansion of e-commerce has significantly transformed consumer purchasing behaviour, particularly in emerging digital economies such as Sri Lanka. Online shopping platforms in present create convenience, accessibility, and variety of products as a part of the modern consumer lifestyle. Despite these developments, online shopping environments continue to cope with service failures, such as delayed deliveries, defective or counterfeit products and payment processing issues. Traditional marketing and consumer behaviour theories suggest that service failures lessen customer satisfaction and result switching behaviour. However, many consumers continue purchasing from the same online platforms even after experiencing such failures. Therefore, this study aims to examine what motivates consumer's willingness to repurchase after experiencing service failures, while also examining the role of e-commerce service tolerance in shaping consumers' purchasing behaviour. This study used a quantitative research design with a minor qualitative component. Data were collected using a structured online questionnaire distributed through convenience sampling, yielding 254 valid responses from individuals who had experienced service failures in online shopping. Quantitative data were analysed using descriptive statistics, correlation analysis, regression analysis, and mediation analysis, while qualitative responses were examined using thematic analysis to capture recurring consumer concerns. The results indicate that perceived economic value, social and situational pressures, platform engagement and habit, and relative shopping advantage have significant positive effects on repurchase intention after service failure experiences, while lack of alternatives does not show a significant direct impact. Correlation analysis further supports these relationships, indicating statistically significant associations among key variables. E-commerce service tolerance demonstrates a significant positive effect on repurchase intention and acts as a critical mediating mechanism explaining why consumers continue purchasing despite dissatisfaction. Qualitative findings reveal that delivery delays, product misrepresentation, refund difficulties, and AI-related service failures are the most frequently reported issues. These findings suggest that consumers in Sri Lanka rationalise service failures as acceptable trade-offs due to economic benefits, convenience, habitual usage, and social influence, thereby extending existing consumer behaviour theories into emerging e-commerce contexts. The study concludes that enhancing service recovery strategies and managing customer expectations are essential for sustaining customer retention in digital marketplaces.

Keywords: *Online shopping, Service failure, Repurchase intention, E-commerce service tolerance*

ADOPTION INTENSITY OF SOLAR PHOTOVOLTAIC (PV) TECHNOLOGY IN EMERGING MARKETS AND THE INFLUENCE OF AFTER-SALES SERVICE: A STUDY IN THE SRI LANKAN CONTEXT

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The growing global demand for sustainable energy and rising electricity consumption have accelerated the adoption of renewable energy technologies across emerging markets. Although solar photovoltaic (PV) technology is a widely recognised renewable energy solution, its adoption intensity in many emerging economies remains below potential due to financial, institutional, technological, and service-related challenges. Despite Sri Lanka's favourable solar irradiance conditions and increasing electricity demand, adoption levels remain lower than expected. This study examined the factors influencing solar PV adoption intensity in Sri Lanka, with particular emphasis on the moderating role of after-sales service. A mixed-method research design was applied, integrating quantitative and qualitative analyses. Quantitative data were collected from solar PV service providers, while qualitative data were collected from potential customers. Data was collected through two separate surveys, and stratified random sampling was applied in both. All data were analysed using Python. Quantitative findings revealed that customer awareness was the only statistically significant direct predictor of adoption intensity ($\beta = 0.346$, $p = 0.018$), exhibiting the strongest correlation ($r = 0.516$). The multiple regression model explained 27.3 % of the variance in adoption intensity ($R^2 = 0.273$). Mediation analysis confirmed that government incentives do not significantly mediate the relationship between financial affordability and adoption intensity, indicating that current incentive mechanisms have limited effectiveness in the Sri Lankan context. Moderation analysis demonstrated that after-sales service significantly moderates the relationship between service quality and adoption intensity ($\beta = -1.169$, $p = 0.022$). Qualitative findings supported these results, identifying high upfront costs and the need for financing as primary barriers, while long-term economic benefits and awareness emerged as key motivators. This study concludes that customer awareness is the dominant driver of solar PV adoption intensity in Sri Lanka, while after-sales service plays a significant moderating role in shaping adoption behaviour. Policymakers and solar PV service providers should prioritise awareness campaigns, accessible financing mechanisms, and reliable after-sales support to accelerate solar PV diffusion in emerging markets.

Keywords: *Solar photovoltaic (PV) systems, Renewable energy policy, Adoption intensity, After-sales service, Emerging markets*

FROM VICIOUS CYCLE TO VIRTUOUS CYCLE: GROWTH BARRIERS FACING SMALL CASHEW-BASED ENTERPRISES IN KAJUGAMA, SRI LANKA

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Small businesses in rural, tourism-dependent localities face compounding structural, financial and institutional barriers that sustain persistent underperformance. This study investigates the key barriers preventing cashew-based small businesses in Kajugama, Sri Lanka, from transitioning from a vicious cycle of low productivity and constrained reinvestment toward a virtuous cycle of sustained growth and competitiveness, while identifying the enabling conditions that facilitate this transition. A quantitative, cross-sectional explanatory research design was employed, with structured questionnaires administered to all 50 tourism-dependent cashew-based small business owner-managers in Kajugama using a census approach, yielding 40 valid responses (80% response rate). Data were analysed using descriptive statistics, Cronbach's alpha reliability analysis, Pearson and Kendall's tau-b correlation analysis and multiple and simple linear regression analysis using IBM SPSS Statistics. Findings reveal that external shocks ($M = 5.00$) and highway construction-related market displacement ($M = 4.86$) represent the most severely perceived barriers, followed by financial and capital constraints ($M = 4.65$) and weak institutional support ($M = 4.36$). Multiple regression analysis identified innovation and value addition ($\beta = 0.704$, $p < 0.001$) and financial constraints ($\beta = 0.411$, $p = 0.001$) as the most significant predictors of small business transition effort, collectively explaining 68.7% of outcome variance ($R^2 = 0.687$). Critically, networking and partnerships emerged as the dominant enabling mechanism, explaining 93.2% of variance in growth effort ($R^2 = 0.932$, $\beta = 0.966$, $p < 0.001$), functioning as a structural bridge through which resource constrained businesses access finance, markets, innovation and institutional support unavailable to individually operating enterprises. Despite severe external pressures, ii ix respondents demonstrated strong entrepreneurial resilience (Level of Effort $M = 4.51$), indicating that current stagnation reflects structural constraint rather than motivational deficit. The study concludes that sustainable vicious-to-virtuous cycle transition requires coordinated multi-dimensional interventions encompassing financial accessibility, innovation support, institutional recognition, digital market integration and systematic networking development targeting Kajugama's predominantly female-led cashew enterprises.

Keywords: *Vicious cycle, Virtuous cycle, Small businesses, Kajugama, Networking and partnership*

TOURIST HARASSMENT BY SMALL-SCALE STREET BUSINESSES (SSSBs) IN GALLE FORT: A STUDY ON ITS NEGATIVE EFFECTS ON DESTINATION SELECTION

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Tourist harassment is a detrimental issue in developing countries. In Sri Lanka, harassment is a critical issue, yet tourism remains one of the major economic drivers. In Galle Fort, Small-Scale Street Businesses such as *Kottu roti* stalls, hopper vendors, and king coconut sellers face allegations of harassment despite their role in enhancing cultural authenticity. These incidents decrease tourist arrivals, cause economic losses for local businesses, and damage the destination reputation. This study aims to examine SSSBs' negative effect on destination image and identify the SSSBs' practices that induce harassment. SSSBs' Tourist harassment is defined as unwanted, persistent, or aggressive behaviour of SSSBs that creates tourist discomfort. This study is grounded in the Tourist Experience and Destination Image framework using mixed-methods, cross-sectional design. The study targeted international tourists exposed to SSSBs in Galle Fort. Data were collected using structured questionnaire comprising a validated 12-item, 5-point Likert scale, supplemented by semi-structured interviews for qualitative insights. Stratified random sampling was used and data saturation was achieved at 197 responses from a target sample of 200, representing 98.5%. The quantitative data was analysed through descriptive statistics and multiple regression analysis to test the predictive effect of harassment on tourist experience, and qualitative data was analysed through thematic analysis. Multiple regression was selected over correlation to test causal effects and control for multidimensionality of harassment. The instrument confirmed high internal consistency, Cronbach's $\alpha = 0.842$, and descriptive results discovered that 89.3% of tourists experienced harassment. Multiple regression analysis confirmed that tourist harassment significantly impacts tourist experience. Thematic analysis resulted in four key themes: price manipulation and hidden charges, misrepresentation of product quality and service delivery, persistent solicitation and intrusion of personal space, and "economic survival pressure" of vendors which leads them to engaging in harassing behaviour. While findings are context-specific to Galle Fort, the operationalised harassment construct and framework are generalisable to other heritage destinations with high SSSB tourism activity. The study concludes that SSSBs' harassment practices damage tourist experience and Sri Lanka's destination image, and recommends policy interventions including vendor training, enforcement of transparent pricing and formalisation of SSSBs to balance economic survival with sustainable tourism.

Keywords: *Tourist harassment, SSSBs, Galle fort, Destination image, Sri Lanka*

EXPLAINING THE FRANCHISE READINESS IN SRI LANKAN RUGBY THROUGH GOVERNANCE, FINANCIAL VIABILITY, ENTERTAINMENT VALUE, AND TECHNICAL EXPERTISE

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Despite its strong cultural visibility, spectator appeal, and long standing school and club traditions, Sri Lankan rugby remains commercially underdeveloped. This study addresses the problem of why Sri Lankan rugby has not developed into a sustainable franchise based competition structure. The objective of the study is to examine how governance, financial viability, entertainment value, and technical expertise influence the franchise readiness in Sri Lankan rugby. The study conducts a quantitative research approach using a structured questionnaire drafted for 70 respondents involved in rugby and cricket in Sri Lanka. Respondents from both sports were included because cricket represents the most commercially successful franchise based sport in Sri Lanka, providing valuable insights for assessing the franchise potential of rugby. The data was analysed using reliability and validity testing, correlation analysis, and multiple regression analysis. The reliability test showed an acceptable Cronbach's alpha value of 0.721. The Kaiser-Meyer-Olkin values for the study variables ranged from 0.521 to 0.873, showing acceptable sampling adequacy. The results show that financial viability is the most influential factor affecting franchise readiness in Sri Lankan rugby. It was revealed by the correlation analysis that financial viability had the strongest positive relationship with franchise readiness ($r = 0.602$), followed by technical expertise ($r = 0.442$) and governance ($r = 0.259$), while entertainment value showed a weak negative relationship ($r = -0.103$). This negative relationship may indicate that entertainment related aspects alone are insufficient to enhance franchise readiness without adequate financial and structural support. The regression model was statistically significant overall ($F = 9.327$, $p < 0.001$) and explained 36.5% of the variance in franchise readiness ($R^2 = 0.365$). However, only financial viability had a statistically significant individual effect on franchise readiness ($B = 0.530$, $p = 0.001$). Governance ($p = 0.686$), technical expertise ($p = 0.898$), and entertainment value ($p = 0.896$) were not statistically significant predictors. The study concludes that franchise readiness in Sri Lankan rugby primarily depends on strengthening financial capacity, commercial stability, and investment potential. Although governance, technical expertise, and entertainment value remain important in broader sport development, financial viability appears to be the key immediate driver of franchise readiness in the current context.

Keywords: *Franchise readiness, Sri Lankan rugby, Financial viability, Governance, Technical expertise*

WORKPLACE SPIRITUALITY, LEADERSHIP, ORGANISATIONAL CULTURE AND EMPLOYEE ENGAGEMENT IN A NOMOLOGICAL NETWORK: EVIDENCE FROM AN AUDIT FIRM IN SRI LANKA

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Employee engagement is an important factor for organisational success, especially in audit firms. Audit firm employees work under high pressure, strict deadlines, and heavy workloads. These conditions can increase stress and reduce employee motivation and engagement. Previous studies have found positive relationships among leadership, organisational culture, workplace spirituality, and employee engagement. However, limited research has examined these variables together within a single audit firm in Sri Lanka. Therefore, this study addresses this research gap. Based on Social Exchange Theory, the study examined the impact of leadership, organisational culture, and workplace spirituality on employee engagement. It also examined the mediating role of workplace spirituality. Leadership refers to the ability of leaders to guide and support employees in achieving organisational goals. Organisational culture refers to the shared values, beliefs, and practices within an organisation. Workplace spirituality includes meaningful work, a sense of community, and alignment between personal and organisational values. This study used quantitative research approach with a cross-sectional design. Due to accessibility constraints, the relatively small population size, and the focus on a single audit firm, a non-probability convenience sampling technique was used. Data were collected from 107 employees of an audit firm using structured questionnaire. Seven hypotheses were tested using correlation analysis, multiple regression analysis, and Sobel mediation analysis. The findings revealed that leadership, organisational culture, and workplace spirituality have significant positive impact on employee engagement. Also leadership and organisational culture have significant positive effects on workplace spirituality. The results also showed that workplace spirituality significantly mediates the relationship between leadership and employee engagement. However, workplace spirituality does not significantly mediate the relationship between organisational culture and employee engagement. The findings highlight the importance of effective leadership, a supportive organisational culture, and meaningful work experiences in improving employee engagement. Future research may examine these relationships across multiple audit firms and other sectors, use probability sampling and longitudinal research designs, and explore additional mediating or moderating variables that influence employee engagement.

Keywords: *Employee engagement, Workplace spirituality, Leadership, Organisational culture, Audit firm*

FACTORS INFLUENCING PURCHASE INTENTION TOWARDS ELECTRIC BIKES AS SUSTAINABLE MODE OF TRANSPORTATION IN THE COLOMBO DISTRICT, SRILANKA

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Transportation is one of the major contributors to greenhouse gas emissions; therefore, promoting the use of electric bikes (e-bikes) can help reduce these emissions. This study aims to examine the factors influencing customers' purchase intention towards e-bikes in the Colombo district. Affordability, perceived performance, and perceived convenience were considered as independent variables, while environmental concern was tested as a mediating variable and purchase intention as the dependent variable. Primary data were collected from 142 individuals who own either an electric bike or a gasoline-powered bike. The study was developed based on the Theory of Planned Behaviour and adopted a quantitative, cross-sectional research design using a stratified sampling method. Hypotheses were tested using multiple regression analysis and mediation analysis through the PROCESS Macro (Model 4) in SPSS 23.0. The results reveal that perceived performance and perceived convenience have significant positive effects on purchase intention, whereas affordability was found to be non-significant. Furthermore, environmental concern did not significantly mediate the relationships between the independent variables and purchase intention. The findings indicate that perceived performance and perceived convenience have significant positive effects on purchase intention towards e-bikes. In contrast, affordability was found to have no significant effect, possibly reflecting consumers' greater emphasis on long-term utility, performance benefits, and convenience over initial purchase cost. Furthermore, environmental concern did not significantly mediate the relationships between affordability, perceived performance, perceived convenience, and purchase intention.

Keywords: *Electric bikes, Purchase intention, Perceived performance, Perceived convenience, Affordability*

DETERMINANTS OF INVESTMENT WILLINGNESS IN THE SRI LANKAN FINANCIAL MARKET: EVIDENCE FROM GENERATION Z PROFESSIONALS WORKING IN BLUE-CHIP COMPANIES, SRI LANKA

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Sri Lanka's equity market participation remains below 5%, even as the economy recovers and digital access to investment platforms improves. This mixed-methods study investigates the determinants of investment willingness among Generation Z professionals employed at executive level or above in blue-chip companies listed on the Colombo Stock Exchange, covering the 2024–2026 post-crisis recovery period. Grounded in the Theory of Planned Behaviour (Ajzen, 1991) and Prospect Theory (Kahneman & Tversky, 1979), the study examines risk tolerance, behavioural biases, and economic growth outlook as direct predictors, with finfluencer influence as a mediating variable and tax implications as a moderating factor. A sequential explanatory mixed-methods design was used. Quantitative data were collected from 203 respondents through a structured online questionnaire distributed via WhatsApp, LinkedIn, and Facebook between March and May 2026. Snowball sampling was adopted, beginning with participants from the researcher's professional networks who then referred other eligible colleagues. Three screening criteria Generation Z birth cohort (1997–2012), employment in a blue-chip or CSE-listed company, and executive-level or higher position were enforced through Google Forms logic. A sub-sample of 32 respondents provided qualitative responses to four open-ended questions. Quantitative data were analysed using PLS-SEM via SmartPLS 4, with path coefficients estimated through bootstrapping with 5,000 resamples ($p < 0.05$). Qualitative responses were examined through thematic analysis. Finfluencer influence emerged as the strongest significant predictor of investment willingness ($\beta = 0.269$, $p < 0.001$) and significantly mediated the relationship between risk tolerance and investment willingness (indirect $\beta = 0.050$, $p = 0.031$). Behavioural biases, economic growth outlook, and tax implications did not produce significant effects, and their corresponding null hypotheses were retained. Qualitative findings identified key barriers including high living costs, low market trust, concerns about insider trading, and insufficient financial communication targeting Gen Z. These results suggest that credible digital financial influencers carry more weight than macroeconomic conditions or tax factors in shaping young professionals' investment intentions, with direct implications for regulators, brokerage firms, and policymakers aiming to broaden retail participation in Sri Lanka's equity market.

Keywords: *Investment willingness, Generation Z investors, Finfluencer influence, Risk tolerance, Behavioural finance*

EVALUATING THE CUSTOMER SATISFACTION OF SHOPPING MALLS STANDARDS IN SRI LANKA

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The shopping malls of Sri Lanka have been found to lack variety, integration and experiences as compared to their international counterparts. Despite the growth of shopping malls in Colombo, there is still a lack of research in understanding what satisfies the customers. This study evaluates the factors that influence customer satisfaction in shopping malls in Sri Lanka. It focuses the influences of four variables: Tenant Mix, Servicescape, Experiential Offering and Retail & Leisure Integration. It also assesses the mediating role played by Product Availability and Pricing Policies. Quantitative and cross-sectional methodologies were adopted for data collection. Structured questionnaires were administered to 260 customers in who visited One Galle Face Mall/ Havelock City Mall/ Marino Mall/ Colombo City Centre Sri Lanka. Reliability, Pearson Correlation, Multiple Regression and Mediation Analysis (PROCESS Macro with 5,000 Bootstrap Samples) were performed using SPSS. All variables exhibited good reliability. Customer satisfaction was found to be low. The multiple regression equation accounted for 81.6% of the variation in customer satisfaction. Tenant Mix, Retail & Leisure Integration and Experiential Offering were identified as the most influential independent variables in influencing customer satisfaction. Servicescape had no significant effect on customer satisfaction. Product Availability was found to play a mediating role in the relationship between Tenant Mix and Satisfaction. Similarly, Pricing Policies were found to mediate the relationship between Experiential Offering and Retail, Leisure Integration with customer Satisfaction. Satisfaction of shoppers at Sri Lankan malls depends on Tenant Mix, Retail and Leisure Integration and Experiential offerings. Product Availability and Pricing Policy are important determinants that help these dimensions affect customer satisfaction. The Servicescape dimension correlates with satisfaction but does not predict it independently of higher-order dimensions. Developers of malls need to focus on tenant mix diversity, mixed-use integration and experiential offerings. Mall managers need to ensure product availability and use experiences to justify pricing. Policymakers can facilitate regional mall development since more than half of mall shoppers are from outside Colombo.

Keywords: *Shopping malls, Tenant mix, Servicescape, Customer satisfaction*

FACTORS THAT MEDIATE THE RELATIONSHIP BETWEEN URBAN FARMING PREFERENCE AND FEASIBILITY IN URBANISED AREA: A CASE STUDY IN KOTAHENA AREA, COLOMBO, SRI LANKA

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The growth in urbanisation has resulted in a limitation on the availability of land and resources for cultivating agricultural crops in an urbanised setting, resulting in a disparity between the preference of urban residents to cultivate their own food and their inability to do so due to certain factors. Kotahena, an urbanised area of Colombo in Sri Lanka, was chosen as the case study because it has a high population density, lack of greenery, and increasing interest of working women in growing food crops in the urban environment. This study aimed to identify the independent variable of urban farming preference (UFP) as a predictor and urban farming feasibility (UFF) as the dependent variable, and to examine the mediating roles of six variables, work-life balance (WLB), space availability (SA), economic viability (EV), local government support (LGS), knowledge and awareness (KA), and sustainability practice (SP) in the relationship between UFP and UFF among employed women in Kotahena. The research utilised a cross-sectional survey approach where data were collected from 261 purposively selected respondents through structured questionnaires using a five-point Likert scale. Data reliability was assured through Cronbach's alpha, while data analysis used Spearman's rank correlation because of the non-normal data distribution detected by the Shapiro-Wilk test. The multiple regression and mediation analyses were run using Hayes' PROCESS Macro (Model 4) in SPSS. The results showed that there is a significant preference for UF practices ($M = 4.08$) despite its moderately high feasibility level ($M = 3.57$). The study found significant positive correlations between UFP and all six mediator variables ($p < 0.05$). The regression analysis shows excellent explanatory power ($R^2 = 0.785$), where KA ($\beta = 0.304$, $p < 0.001$), SA ($\beta = 0.261$, $p < 0.001$), and EV ($\beta = 0.198$, $p < 0.01$) are highly significant determinants of UFF. The mediation test showed significant indirect effects of UFP on UFF through KA (indirect effect = 0.142, 95% confidence interval [0.089, 0.201]), SA (indirect effect = 0.118, 95% confidence interval [0.071, 0.174]), EV (indirect effect = 0.097, 95% confidence interval [0.052, 0.148]), WLB (indirect effect = 0.063, 95% confidence interval [0.021, 0.112]), and LGS (indirect effect = 0.049, 95% confidence interval [0.011, 0.094]). In contrast, the SP factor had a non-significant indirect effect. The results show that only having a higher urban farming preference is not enough for feasibility, and that gaining knowledge, planning spaces, economic support, and proper governance are very important mediations. The study contributes empirical evidence to urban agriculture policy in South Asian contexts and recommends targeted interventions to bridge the preference–feasibility gap for urban employed women.

Keywords: *Urban farming preference, Urban farming feasibility, Knowledge and awareness, Space availability, Economic viability*

Acknowledgement: *This research received no specific grant from any funding agency.*

FACTORS INFLUENCING REGULATORY COMPLEXITY IN SOLAR POWER ADOPTION AMONG FINANCIALLY CAPABLE HOUSEHOLDS: A CASE STUDY OF THE KALUTARA DISTRICT

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Sri Lanka targets 70% renewable energy generation by 2030, with solar power playing a central role. Despite favourable irradiation conditions and financially capable households, residential solar adoption remains critically low. While prior research has attributed this to economic barriers, this study examines non-economic impediments specifically, Regulatory Complexity as the primary barrier among financially capable households in the Kalutara District. Grounded in Institutional Theory, New Institutionalism Theory, Theory of Planned Behaviour, Real Options Theory, Diffusion of Innovations Theory, and Regulatory Focus Theory, the study investigates the effects of Institutional Capacity, Trust, Communication, Market Uncertainty, and Awareness on Regulatory Complexity, with Private Sector Involvement (PSI) as a mediator. A quantitative, deductive design was employed, with data collected via a structured questionnaire administered to 212 financially capable households through non-probability convenience sampling across five Divisional Secretariat divisions in the Kalutara District. Data were analysed using multiple regression analysis and Hayes PROCESS Model 4. Institutional Capacity ($\beta = 0.210$, $p = 0.003$), Trust ($\beta = 0.197$, $p = 0.018$), and Communication ($\beta = 0.171$, $p = 0.025$) significantly and positively predicted Regulatory Complexity (H_{a1} , H_{a2} , H_{a3} supported), while Awareness ($\beta = -0.085$, $p = 0.207$) and Market Uncertainty ($\beta = -0.026$, $p = 0.712$) did not (H_{a4} , H_{a5} not supported). The model explained 61.8% of variance ($R^2 = 0.618$, $p < 0.001$). The positive direction of significant predictors reflects a regulatory learning effect: households that are more institutionally engaged and better informed perceive procedural complexity more acutely. PSI significantly mediated all five hypothesised pathways (H_{a6} – H_{a10} supported), acting as a complementary partial mediator for Institutional Capacity, Trust, and Communication, and as a suppression mediator for Awareness and Market Uncertainty. The study concludes that regulatory complexity is shaped by institutional, trust-based, and communicative factors rather than economic barriers alone. Private Sector Involvement consistently reduces perceived complexity, functioning as a key regulatory facilitator. These findings advance knowledge on non-economic barriers to renewable energy adoption and offer practical guidance for policymakers to streamline net metering processes, improve Ceylon Electricity Board and Sustainable Energy Authority communications, and foster public–private partnerships to accelerate residential solar uptake in Sri Lanka.

Keywords: *Regulatory complexity, Solar power adoption, Communication, Private sector involvement, Kalutara district*

PUBLIC PERCEPTION OF SERVICE QUALITY IN MUNICIPAL SUPERMARKETS IN COLOMBO, SRI LANKA, THE INFLUENCE OF INFRASTRUCTURE, MANAGEMENT AND DEVELOPMENT PRACTICES

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Municipal supermarkets in Sri Lanka continue to play an important socio-economic role by ensuring access to affordable consumer goods, supporting urban food distribution, and contributing to local economic development. However, the rapid expansion of private supermarket chains has intensified competition and these modern retailers have dramatically elevated consumer perceptions of service quality, modern infrastructure and operational efficiency and customer experiences in urban centers. Hence, municipal supermarkets face increasingly tough competition in their efforts to retain public support and market presence. Public retail institutions are more important than ever in urban economics. The purpose of this research, therefore, is to determine how service quality perception of municipal supermarkets in Colombo, Sri Lanka is influenced by physical infrastructure conditions, service management, and development related factors. The study adopted a quantitative cross sectional design based on SERVQUAL model and Retail Service Quality Scale (RSQS) model. Primary data was obtained from 180 consumers by the means of structured questionnaire surveys collected across the selected municipal supermarkets in Colombo. Descriptive statistics and the inferential statistics were used for data analysis. The findings reveal that physical infrastructure condition is the strongest determinant of public perceived service quality ($= 0.327, p < 0.001$), revealing that modern facilities, upkeep and cleanliness, accessibility and overall maintenance of municipal supermarkets will strongly influence customer perceptions. Service management aspect such as customer orientation has also had significant positive effect on the perception of service quality ($= 0.251, p = 0.002$). It was found that ambient conditions partially mediate the relationship between customer orientation and service quality perception, whereas Public-Private Partnership potential plays a significant moderating role on service quality perception by the virtue of government administration. The study suggests that physical infrastructure enhancement, customers-oriented management practices, development promoting actions and effective Public-Private Partnership is critical in order to enhance public perception of service quality of municipal supermarkets. It further contributes to the sparse literature in public retail service quality in developing countries and offers policy implications for municipal authorities in striving to modernisation of public retail services, enhancing consumer satisfactions, maintaining competitiveness and sustainability of municipal supermarkets in Sri Lanka.

Keywords: *Service quality perception, Municipal retailing supermarkets, Customer orientation, Infrastructure conditions, Public-private partnership*

ETHICAL WORK ENVIRONMENT IN THE GIG ECONOMY: A SPECIAL REFERENCE TO PICKME TUK-TUK DRIVERS IN COLOMBO

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The gig economy has revolutionised urban transportation and provided a new and flexible way to work for many people. On the other hand, concerns regarding the ethical work environment of platform-based workers have grown, especially in developing countries like Sri Lanka. Income stability, customer pressure, weak labour protection, limited organisational transparency are among the major challenges faced by pickMe tuk-tuk drivers, which affect their perceptions of fairness and ethical treatment. Therefore, this study aims to identify the factors affecting the perceived ethical work environment of PickMe tuk-tuk drivers in the Colombo District. Selected variables are institutional, behavioural, and stakeholder-related factors that have been identified in the previous studies as crucial determinants of ethical work environments within gig economy platforms. A quantitative research design was used to identify the relationship between those selected variables. Since there was no reliable list of registered PickMe tuk-tuk drivers in the Colombo District, convenience sampling was initially used to find available respondents and snowball sampling was used to find other eligible drivers via referrals. The 104 registered PickMe tuk-tuk drivers were given a structured Likert scale questionnaire. Also, informal conversations with drivers during data collection were conducted to gain contextual information that helped to interpret the quantitative findings. The analysis results reveal that the measurement model illustrated high reliability and consistency. The results indicate that, Government regulation and policies, willingness to continue working, and negative customer feedback have a significant positive impact. This suggests that drivers intending to remain on the platform report greater satisfaction, trust and commitment. In contrast, Negative social media influence has a negative effect, this means that negative online comments/perceptions can affect customer attitudes, driver confidence, and perceptions of fairness in the platform environment, while drivers' ethical knowledge and awareness of customer perceptions were not found to have a statistically significant effect. The study found that structural and external factors mainly shape drivers perceived ethical work environment. To create fair and sustainable work environment for gig workers, regulatory frameworks need to be improved, platform transparency must be enhanced, and accountability of platforms must be essential. These findings contribute to the gig economy ethics literature in Sri Lanka and provide practical information to improve fairness, transparency and ethical working conditions.

Keywords: *Ethical work environment, Gig economy, Pick me drivers, Customer feedback, Social media influence*

EXPLORING THE COFFEE RESTAURANT DEVELOPMENT OVER TEA CONSUMPTION IN SRI LANKA: SPECIAL REFERENCE TO MILLENNIALS AND GEN Z

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Sri Lanka, long recognised as one of the world's leading tea-producing nations, is experiencing a marked shift in urban beverage culture, with coffee cafés increasingly preferred over traditional tea outlets among younger consumers. This study examines the factors driving consumer attractiveness to coffee over tea among Millennials and Generation Z in the Colombo and Gampaha districts in Sri Lanka. A mixed-methods, cross-sectional design was used, combining a structured online survey of 176 respondents (65% Generation Z, 35% Millennials) with open-ended qualitative questions. Five independent variables - lifestyle, ambience preference, social interactions, branding, and product innovation were tested as predictors of attractiveness to coffee over tea, while social media and sustainability practices were examined as moderators, drawing respectively on theories of digital consumer engagement and green consumer behaviour. Data was analysed through descriptive statistics, reliability testing, correlation, and multiple regression using SPSS. The findings showed that 70% of respondents expressed greater attractiveness toward coffee over tea, and the regression model explained 78.5% of the variance in this outcome ($R^2 = 0.785$). Ambience preference, social interaction, branding, and product innovation were statistically significant predictors, while lifestyle was not. Social media significantly moderated the relationship between social interaction and coffee café preference, whereas sustainability did not moderate the branding–attractiveness relationship. All scales showed excellent internal consistency (Cronbach's alpha > 0.92), though such high values may indicate item redundancy that warrants scale refinement in future research. The qualitative responses reinforced these results, portraying coffee cafés as multifunctional spaces for relaxation, socialising, and digital sharing that traditional tea outlets have yet to replicate. As the sample spans two generational cohorts, this study lays the groundwork for future research to formally compare Millennial and Generation Z patterns, since the present analysis was conducted at the combined-sample level. Overall, the findings suggest that the growth of coffee café culture in Sri Lanka is driven primarily by experiential, social, and digital factors rather than lifestyle or sustainability concerns, and recommend that the tea industry modernise its branding, ambience, and digital presence to remain competitive among younger consumers.

Keywords: *Coffee cafe culture, Tea consumption, Millennials, Generation Z, Sri Lanka*

THE IMPACT OF SALESPERSON INTRUSIVENESS ON PURCHASE INTENTION: THE MEDIATING ROLE OF EMOTIONAL COMFORT AND PERCEIVED AUTHENTICITY, AND THE MODERATING ROLE OF SHOPPING MOTIVATION IN SRI LANKAN APPAREL RETAIL STORES

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In modern retail environments, customer experience has become a critical factor influencing consumer behaviour and purchase decisions (Verhoef et al., 2009). While salespersons are expected to provide assistance and maintain service quality in apparel retail stores, excessive interaction may be perceived as intrusive, potentially reducing customer purchase intention (Aguirre et al., 2015). This study examined the impact of salesperson intrusiveness on purchase intention among customers of Sri Lankan apparel retail stores, with emotional comfort and perceived authenticity as mediating variables and shopping motivation as a moderating variable. A quantitative research approach was adopted, and data were collected from 100 apparel retail customers in Sri Lanka using a structured questionnaire through convenience sampling. Correlation and multiple regression analyses were employed to test the proposed relationships. The findings indicated that salesperson intrusiveness negatively influenced purchase intention, while emotional comfort and perceived authenticity significantly mediated this relationship. Furthermore, shopping motivation moderated the effect of salesperson intrusiveness on purchase intention, with hedonic shoppers showing stronger negative responses to intrusive salesperson behaviour than utilitarian shoppers. The study contributed to the consumer behaviour and retail marketing literature by providing empirical evidence on the effects of salesperson intrusiveness in the Sri Lankan apparel retail context and offered practical implications for retail managers seeking to balance proactive customer service with customer autonomy and comfort.

Keywords: *Emotional comfort, Perceived authenticity, Purchase intention, Salesperson intrusiveness, Shopping motivation.*

AWARENESS OF DISINFORMATION OUTCOMES ON SOCIAL MEDIA SOURCES: GEN Z EMPLOYEES IN THE PRIVATE SECTOR IN WESTERN PROVINCE, SRI LANKA

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In Sri Lanka, social media has become one of the most influential platforms for information sharing, but it is also a major channel for the rapid spread of disinformation. Although many users, particularly Gen Z employees in the private sector, are increasingly exposed to false or misleading content, their awareness of the consequences of disinformation remains unclear. This study aims to identify the level of awareness regarding disinformation outcomes and to determine the specific factors, including digital literacy, critical thinking, confirmation bias, education level, media consumption patterns, FOMO (Fear of Missing Out), and peer pressure, that can impact awareness of disinformation outcomes among Generation Z employees in the private sector of the Western Province, Sri Lanka. A quantitative research design was conducted. Data for this study will be collected from 106 respondents using a structured questionnaire through an online survey. The data was analysed using the Statistical Package for the Social Sciences (SPSS) software. The results indicate that digital literacy has the strongest positive and statistically significant relationships with awareness of disinformation outcomes. Confirmation bias and critical thinking also demonstrated a strong positive association, while education level showed a weak but significant relationship. Conversely, media consumption patterns were found to have no significant impact on awareness levels. Multiple regression analysis revealed that 70.1% of the variation in awareness of disinformation outcomes is explained by the combined effect of independent variables. Moderation analysis further established that Fear of Missing Out (FOMO) significantly weakens the positive relationship between critical thinking/confirmation bias and awareness of disinformation outcomes. The study concludes that while there is moderate awareness, it is heavily dependent on individual analytical skills and digital competencies rather than simple media exposure. Therefore, targeted interventions focusing on enhancing digital literacy and critical thinking are essential to mitigate the harmful impacts of information disorder within the Sri Lankan workforce.

Keywords: *Disinformation, Digital literacy, Critical thinking, Confirmation bias, FOMO*

INVESTIGATING THE LEVEL OF IMPLEMENTATION OF EXTENDED PRODUCER RESPONSIBILITY (EPR)-BASED FOOD PACKAGING WASTE MANAGEMENT BY SMALL AND MEDIUM ENTERPRISES (SMEs) IN THE COLOMBO DISTRICT, SRI LANKA

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The level of Extended Producer Responsibility (EPR) implementation in food packaging waste management in Sri Lanka remains at a developing stage, with varying degrees of adoption among Small and Medium Enterprises (SMEs). Previous studies have not sufficiently examined the implementation level of EPR practices among SMEs in Sri Lanka. This study looks at how well small and medium businesses in areas of Sri Lanka are managing food packaging waste through Extended Producer Responsibility. The areas include Colombo Pettah, Wellawatte, Kollupitiya, Borella and Nugegoda (Department of Census and Statistics Sri Lanka, 2023). At its core, the research looks at how five factors shape EPR implementation: financial barriers, regulatory and policy barriers, technological barriers, supply chain and transportation barriers, and organisational culture. It also explores whether a business's capacity to invest in green practices and its level of environmental awareness change how those factors play out. Using a structured questionnaire, data were collected from 114 SMEs in the Colombo District and analysed through reliability analysis, descriptive statistics, correlation analysis, regression analysis, and moderation analysis in the Statistical Package for Social Sciences (SPSS). The scales used were reliable, with Cronbach's Alpha values between 0.801 and 0.889. The results show that EPR practices are being picked up by SMEs, but only to a moderate degree present in some businesses, but far from deeply embedded. Financial, regulatory, technological, and supply chain barriers all meaningfully dragged down implementation levels, while a strong organisational culture did the opposite, actively pushing adoption forward. The model accounted for 62.7% of the variance in EPR implementation. Looking deeper, businesses with greater investment capacity in green practices were better placed to push past financial and technological hurdles, and higher environmental awareness helped soften the weight of regulatory barriers while amplifying the positive pull of a good organisational culture. Taken together, the findings make clear that EPR still has a long way to go among SMEs in the Colombo District. Tackling the structural barriers and building both investment capacity and environmental awareness will be key to moving the needle on sustainable waste management in this sector.

Keywords: *Extended producer responsibility (EPR), Small and medium enterprises (SMEs), Food Packaging Waste, Sustainability, Waste management*

FACTORS INFLUENCING THE CONTINUED CONSUMPTION OF FIZZY DRINKS AMONG WORKING INDIVIDUALS IN THE COLOMBO DISTRICT DESPITE AWARENESS OF HEALTH RISK

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Despite increasing awareness of the health effects associated with fizzy drink consumption, many people continue to drink such products regularly. The consumption of excessive fizzy drinks has been found to cause certain health conditions like obesity, diabetes, dental problems, and heart diseases. Nevertheless, being aware of these health effects does not guarantee that lead to healthy consumption behaviour of such beverages. Hence, the study intends to determine the variables that determine the persistence in the consumption of fizzy drinks despite health risks by working individuals in the Colombo District. This study explored how health risk awareness, the impact of advertisements, brand trust, perceived benefits, and habit formation affected the continuous use of fizzy drinks by individuals in the study area, based on the principles of consumer behaviour. Besides, social influence and convenience were taken into consideration in determining consumer behaviour. Quantitative research methodology with descriptive cross sectional survey design was used for this purpose. The target population for the study comprised working individuals aged below 50 years, living in Colombo District, and consuming fizzy drinks on at least weekly basis. 110 respondents were randomly chosen through convenience sampling technique. Validity and reliability of the measurement instrument were determined before data analysis where the results showed that Cronbach's Alpha values surpassed the cutoff point. SPSS was used to conduct descriptive and Pearson correlation analysis. The results show that all independent variables were positively correlated with continued use of fizzy drinks ($p < 0.05$). Brand trust had the strongest correlation with continued consumption ($r = 0.662$). Habitual behaviour showed high correlation with continued consumption ($r = 0.622$). Other predictors that showed strong correlations with continued consumption were advertising influence ($r = 0.444$), benefits of the product ($r = 0.305$), and health risk awareness ($r = 0.252$). Health risk awareness, advertising influence, brand trust, and social influence were correlated, whereas convenience was correlated with benefits. These findings suggest that increased health awareness may not be enough to change behaviour and stop the consumption of fizzy drinks. In comparison, behaviours such as habit, advertising, social influence, and branding were major contributors in increasing consumption behaviours. This research is crucial to policymakers and marketing specialists as it informs them on the importance of developing more effective interventions to change consumption behaviours towards healthier alternatives.

Keywords: *Fizzy drinks, Consumption behaviour, Perceived benefits, Brand trust*



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DESIGN AND DEVELOPMENT OF A LOW-FREQUENCY KINETIC ENERGY HARVESTER FOR ELEPHANT TRACKING COLLARS

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GPS tracking collars are essential tools for Human-Elephant Conflict (HEC) mitigation, yet their operational lifetime remains fundamentally constrained by finite battery capacity, and replacing depleted batteries requires chemical immobilisation of the animal - a procedure carrying serious physiological risks and substantial financial burden on conservation programs. Existing renewable alternatives, particularly solar panels, have proven largely ineffective in dense forest habitats where canopy cover limits sunlight and elephant behaviours such as mud bathing and tree rubbing rapidly degrade exposed surfaces, leaving a largely unexplored gap for a fully environmentally independent power source suited to elephant-worn electronics. To address this, This study proposes harvesting low-frequency kinetic energy from the natural walking motion of elephants using a linear electromagnetic generator (LEG) comprising neodymium permanent magnets, copper induction coils, and a spring-mass suspension tuned to resonate at the typical elephant gait frequency of 1-2 Hz, with the raw AC output conditioned through a Schottky diode bridge rectifier and a BQ25570 nano-power boost charger feeding a dual-stage energy storage architecture combining a super capacitor buffer with a lithium-polymer battery. Bench-top experiments conducted at a simulated walking frequency of 1.5 Hz revealed that a single magnet with one coil layer produced only 60 mV - well below the 600 mV cold-start threshold required by the BQ25570 - confirming that stacking multiple magnet layers is technically necessary rather than merely beneficial. As coil layers increased from one to two and magnet count increased from one to three, the generated voltage rose from 60 mV to 500-600 mV, successfully reaching the operational threshold of the power management circuit and demonstrating a clear, reproducible relationship between generator geometry and output voltage. Although the current work establishes feasibility at the proof-of-concept component level, the measured output compares favourably with the power demands of typical low-duty-cycle GPS collar systems, confirming biomechanical energy harvesting as a technically viable and environmentally independent power source for wildlife tracking electronics, with future work focusing on mechanical optimisation, system-level integration, and field validation under real elephant movement conditions.

Keywords: *Energy harvesting, Electromagnetic induction, Human-elephant conflict, Wildlife monitoring, GPS tracking collar*

DEVELOPMENT OF A NATURAL DYE FROM *Artocarpus nobilis* LEAF PIGMENTS FOR SUSTAINABLE COTTON DYEING

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A crucial change is happening in the global textile industry due to growing environmental and health concerns regarding synthetic colourants. Most of the industrial applications employ synthetic dyes, especially azo based dyes, because of their wide colour range and economic viability. However, their structural stability renders them surprisingly resistant to aerobic biodegradation and their susceptibility to reductive cleavage can release carcinogenic aromatic amines, such as benzidine and 4-aminobiphenyl, which constitute serious ecological and human health risks. The present study aimed to explore the potential use of *Artocarpus nobilis*, a native to Sri Lanka and popularly called Ceylon breadfruit, as a sustainable and ecofriendly natural dye for cotton fabrics. The research in particular concerns the extraction of pigments from leaves a waste product in agriculture, with water, which favours a circular economy and reduces the environmental impact of textile processing. The dyeing performance on scoured cotton fabric was optimised using ferrous sulfate as a mordant at concentrations of 1%, 3% and 5%. The use of different concentrations of iron produced a saddening effect, moving the aesthetic character of the dyed textiles from light colours to durable darker colours such as olive, slate grey and deep black. This darkening phenomenon is attributed to the chemistry of the formation of ferric tannate complexes between the iron ions and the rich polyphenolic and tannin content of the extract of *Artocarpus nobilis*. A key aspect of the present study was the verification of the photostability of the dyed textiles by a severe weathering test. Samples were kept in an open area under direct UV sunlight for 5 days at a stretch to monitor any change in colour. The experimental results demonstrated a definite correlation between the mordant concentration and the durability, with increased ferrous mordant concentration resulting in reduced colour change, with the 5% concentration being the most UV stable. This implies that higher mordant levels favour more extensive chemical bonding and coordination and hence protect the organic chromophores from photodegradation. The study concluded that *Artocarpus nobilis* leaf extract is a practical, cheap and environmentally sustainable alternative to synthetic dyes. The first observations give promising results but further work will involve standard fastness tests and molecular characterisation by FTIR to confirm these results.

Keywords: *Artocarpus nobilis*, Natural dye, Cotton, Mordant, Sustainable textile



ENVIRONMENTAL AND CHEMICAL SCIENCES

EXPLORING THE POTENTIAL OF PHTHALOCYANINE-BASED Mn(II) COMPLEX FOR DYE DECOLOURISATION: DEMONSTRATED ON SELECTED AZO AND XANTHENE DYES

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Currently, synthetic dyes are extensively used across industries; however, their toxicity, stability, persistence, and bioaccumulation cause significant ecological and health risks. As wastewater is the primary route through which these dyes enter the ecosystem, effective treatment strategies are required to efficiently remove dyes from wastewater effluents. Although metal phthalocyanines have been investigated as catalysts for wastewater treatment, comparative studies evaluating the oxidative and photocatalytic decolourisation performance of manganese(II) phthalocyanine (MnPc) toward different dye classes remain limited. Therefore, in this study, MnPc metal complex was synthesised and comparatively investigated for its ability to oxidatively and photocatalytically decolourise selected dye classes, namely azo and xanthene dyes, under optimal conditions. The synthesised metal phthalocyanine complex was characterised using FTIR and UV-Vis spectroscopy, with the observed spectral features being consistent with the successful formation of the phthalocyanine framework. To optimise the decolourisation process, the effects of pH, dye concentration, MnPc concentration, time, and H₂O₂ concentration were investigated using the Taguchi statistical method, enabling reliable evaluation with reduced experimental cost and time. In this study, photocatalytic decolourisation efficiency was studied by irradiating the MnPc-dye systems at 366nm, whereas oxidative decolourisation was studied under dark conditions. Absorbance was monitored by UV-Vis spectroscopy to assess the extent of dye decolourisation. Comparative control studies were also performed to investigate the photocatalytic decolourisation effect of MnPc under 366 nm and 254 nm irradiation. Furthermore, the kinetics of these dye-MnPc systems were analysed to gain insight into the probable mechanisms of MnPc-mediated dye decolourisation. In conclusion, MnPc exhibited photocatalytic decolourisation efficiencies of 41% and 22% for tartrazine and rhodamine B, respectively, while oxidative decolourisation efficiencies reached 58% and 26%, respectively. These results convincingly suggested that oxidative decolourisation was greater for both dyes, while tartrazine showed a greater decolourisation tendency than rhodamine B in both processes. In addition, all systems except the photocatalytically decolourised MnPc-tartrazine system showed pseudo-first-order kinetic model fitting, suggesting radical-driven dye decolourisation, whereas photocatalytic MnPc-tartrazine exhibited greater linearity with the zero-order model, indicating probable adsorption-dominant dye removal. When the dye-MnPc systems were irradiated with 254 nm light, they showed higher decolourisation efficiencies, highlighting the combined effect of MnPc-mediated decolourisation and direct photolysis. The findings of this study demonstrate the potential of MnPc-based catalytic systems as an efficient and tunable method for wastewater remediation.

Keywords: Dye decolourisation, Manganese(II) phthalocyanine, Photocatalytic, Oxidative, Taguchi method.

PHYSICOCHEMICAL PROPERTIES AND CRYSTALLINITY OF COMMERCIALY AVAILABLE HIMALAYAN ROCK SALT

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Himalayan rock salt, primarily composed of halite (NaCl), is widely used in Traditional Medicine because of its therapeutic properties. Despite its extensive application, no standard parameters have yet been developed through a scientifically validated process. This study aimed to provide baseline information for the development of standard specifications for commercially available Himalayan rock salt in Sri Lanka. Six Himalayan rock salt samples obtained from different vendors in local markets were analysed in triplicate for physicochemical parameters, including pH, water insoluble matter, acid insoluble matter, moisture content, and specific gravity. The crystalline structure was determined using X-ray diffraction (XRD). The data were statistically analysed using one-way ANOVA. The physicochemical analysis revealed that all salt samples were slightly acidic with pH ranging from 4.9 to 6.3. The salt exhibited considerable heterogeneity in impurity content, with water insoluble matter ranging from 1.73% to 5.67% and acid insoluble matter ranging from 2.89% to 12.18%. The samples demonstrated low moisture content (<1.5%). One-way ANOVA revealed statistically significant differences among salt samples in terms of pH ($p < 0.001$), water insoluble matter ($p = 0.0029$), acid insoluble matter ($p = 0.0017$), and moisture content ($p = 0.0087$). In contrast, specific gravity values ranged from 2.04 to 2.31, showing no statistically significant differences among the samples ($p = 0.492$), indicating relatively uniform bulk density despite variations in other physicochemical parameters. XRD analysis confirmed that all samples predominantly consisted of the face-centred cubic structure of halite. Sharp, high-intensity diffraction peaks indicated highly crystalline and well-ordered structures, while secondary peaks suggested the presence of trace mineral constituents. In conclusion, commercially available Himalayan rock salt samples exhibited substantial variability in pH, impurity content, and moisture content, whereas specific gravity remained relatively uniform. Despite these physicochemical differences, all samples shared a highly crystalline halite structure. These findings provide baseline physicochemical and crystallinity data and highlight the importance of establishing standardised quality parameters for Himalayan rock salt.

Keywords: *Himalayan rock salt, Physicochemical properties, XRD, Halite, Crystallinity*

GLOBAL WARMING POTENTIAL OF TECHNICALLY SPECIFIED RUBBER (TSR) PRODUCTION IN SRI LANKA: A COMPARATIVE CRADLE-TO-GATE LIFE CYCLE ASSESSMENT ACROSS THREE FACTORIES

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Technically Specified Rubber (TSR) is a major export commodity in Sri Lanka's rubber industry. However, its energy-intensive processing contributes significantly to greenhouse gas emissions. Despite growing demand for low-carbon natural rubber, comparative studies quantifying the Global Warming Potential (GWP) of TSR production remain limited. This study addresses this gap through a cradle-to-gate Life Cycle Assessment (LCA) of TSR production across three factories with contrasting energy sources and raw material inputs. The assessment followed ISO 14040 and ISO 14044 standards using SimaPro 10.2 software and the Ecoinvent v3.9 database. The ReCiPe 2016 Midpoint (H) method, with the CML-IA baseline v3.11/EU25 setup, was applied for impact assessment. The functional unit was one tonne of TSR, with system boundaries covering rubber cultivation, raw material processing, transportation, and manufacturing. Sensitivity analysis was conducted using multiple LCIA methods. Cup lumps, the primary TSR feedstock, had an allocated GWP of 30.052 kg CO₂ eq per tonne because only approximately 10% of the latex yield over a rubber tree's productive lifespan is recovered as cup lumps, with the remaining 90% allocated to other rubber products. Plantation-level latex production contributed a GWP of 8.11×10^2 kg CO₂ eq per tonne. Total cradle-to-gate GWP values were 8.58×10^2 , 6.98×10^2 , and 3.77×10^2 kg CO₂ eq for Factories A, B, and C, respectively. The dominant driver of these differences was the energy source used during drying and processing. Factory A recorded the highest emissions due to intensive use of charcoal, wood chips, grid electricity, and diesel, while Factory B exhibited higher GWP than Factory C partly because of the inclusion of Ribbed Smoked Sheet (RSS) rubber as an intermediate input (GWP: 2.36×10^3 kg CO₂ eq). Factory C achieved the lowest GWP through more than 85% utilisation of solar electricity, minimal reliance on the national grid, and elimination of biomass fuels. TSR manufacturing involved only physical, water-based processes without chemical additives. Sensitivity analysis using ReCiPe 2016 Midpoint (H), IMPACT 2002+, Eco-indicator 95, and EPD 2018 consistently ranked Factory A as having the highest GWP and Factory C the lowest, demonstrating the robustness of the comparative results. These results demonstrate that energy source selection is the primary driver of GWP, while raw material composition plays a secondary role. The findings highlight that increased adoption of solar energy and optimised raw material selection provide a practical pathway for decarbonising Sri Lanka's TSR industry, improving environmental performance and enhancing competitiveness in increasingly carbon-conscious global markets.

Keywords: *Technically specified rubber (TSR), Global warming potential (GWP), Cradle-to-Gate life cycle assessment, Solar energy, Sri Lanka*

EFFECT OF TRADITIONAL PURIFICATION ON THE PHYSICOCHEMICAL PROPERTIES OF ARSENIC TRIOXIDE (*GAURIPASHANA*) USING EXTRACT OF BITTER GOURD

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Arsenic trioxide (*Gauripashana*, As₂O₃) is a toxic inorganic arsenic compound that has been used in traditional medicine after undergoing different purification processes to enhance its therapeutic properties. Despite its long history of use in traditional medicine, limited scientific studies have been conducted to investigate the physicochemical changes that occur during the purification processes. Hence, the present study was conducted to evaluate the changes in physicochemical properties of arsenic trioxide (*Gauripashana*) before and after purification using the bitter gourd (*Momordica charantia*) extract as the purification medium. After the purification process, the purified and unpurified samples were evaluated based on the physicochemical parameters as pH value, loss on drying, alcohol-soluble extractive value, water-soluble extractive value, and the X-ray diffraction (XRD) analysis. The pH value was shifted from the slightly acidic pH (6.95 ± 0.04) in the unpurified sample to a slightly alkaline pH (7.33 ± 0.34) in the purified sample. Loss on drying (LOD) value was increased from $0.17 \pm 0.02\%$ (before purification) to $0.97 \pm 0.08\%$ (after purification). Alcohol soluble extractable matters were slightly increased from $7.61 \pm 0.22\%$ to $7.82 \pm 1.14\%$ and the water-soluble extractable matters were also increased from $11.10 \pm 0.27\%$ to $14.54 \pm 0.09\%$. XRD analysis confirmed that the crystal structure of both purified and unpurified samples retained the same cubic arsenolite crystal structure (according to the standard 00-036-1490 DCPDS reference) of As₂O₃ without any phase transformation. These findings indicate that the applied purification method did not significantly change the crystal structure of arsenic trioxide (*Gauripashana*). However, noticeable changes in the physicochemical parameters were observed after purification. These findings indicate possible interactions between arsenic trioxide and the organic compounds present in bitter gourd extract during the purification process.

Keywords: *Gauripashana*, Arsenic trioxide, Traditional purification, Physicochemical properties, XRD analysis

ANALYTICAL VALIDATION AND COMPARATIVE ASSESSMENT OF OLSEN AND MEHLICH-3 PHOSPHORUS EXTRACTION METHODS IN ACIDIC AGRICULTURAL SOILS

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Measuring plant-available soil phosphorus (P) accurately is important for sustainable agriculture. The Olsen method (using 0.5 M NaHCO₃ at pH 8.5) is a widely used and cost-effective laboratory technique, but it was originally designed for neutral or alkaline soils. Because most agricultural soils in Sri Lanka are acidic, using an alkaline extractant like the Olsen method raises concerns about chemical matrix interferences and inaccurate readings. While acidic extractants like the Mehlich-3 method (using a mixture of 0.2 M CH₃COOH, 0.25 M NH₄NO₃, 0.015 M NH₄F, 0.013 M HNO₃ and 0.001 M EDTA at pH 2.5) are theoretically better suited for our local low-pH soils, they are much more expensive and complex for local laboratories to run on a daily basis, requiring sophisticated and costly instruments such as ICP-OES or ICP-MS. This study aimed to analytically validate the Olsen method for acidic Sri Lankan soils and statistically compare its extraction performance against the Mehlich-3 method. Additionally, we investigated how the natural soil pH affects the extraction efficiency of both methods. First, the Olsen method was validated for linearity, precision, and accuracy using potassium dihydrogen orthophosphate certified reference material. Next, ten representative agricultural soil samples from Sri Lanka, with pH values ranging from 5.65 to 6.98, were analysed using both the Olsen and Mehlich-3 protocols. The resulting data was evaluated using Shapiro-Wilk normality tests, Paired-Samples t-tests, and Spearman rank correlation analysis ($p < 0.05$). The validation showed that the Olsen method is highly reliable ($R^2 > 0.995$, Limit of Quantification = 1.61 mg kg⁻¹) with excellent recovery (98.9% to 102.7%), even with some matrix interferences in heavier clay soils. Interestingly, a paired t-test showed no statistically significant difference ($t = -0.811$, $p = 0.438$) in the amount of P extracted by the two different methods. Furthermore, Spearman correlation tests revealed a strong positive relationship between the native soil pH (1:5 ratio) and the P extracted by both the Olsen ($\rho = 0.830$, $p = 0.006$) and Mehlich-3 ($\rho = 0.709$, $p = 0.028$) methods. These findings confirm that the cost-effective Olsen method performs just as well as the Mehlich-3 method for local acidic soil samples. The data also highlights that natural soil pH is a primary factor controlling P availability. Ultimately, local analytical laboratories can confidently continue using the economical Olsen method for soil testing without compromising scientific accuracy.

Keywords: *Available phosphorus, Olsen method, Mehlich-3, Soil type, Analytical validation*

SYNTHESIS AND CHARACTERISATION OF A BIODEGRADABLE HYDROGEL FERTILISER ENRICHED WITH ZnO NANOPARTICLES, NPK FERTILISER AND NAPHTHALENE ACETIC ACID FOR SUSTAINABLE AGRICULTURE

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Hydrogels with extended-release behaviour of nutrients are positioned as a promising solution for enhancing crop productivity as a potential solution for the global food security concern, and to overcome environmental issues caused by conventional chemical fertilisers. The improved agricultural attention on hydrogels led the path to synthesise and characterise fertiliser hydrogel, enriched with zinc oxide nanoparticles (ZnO NPs), naphthalene acetic acid (NAA), and Nitrogen, Phosphorus, and Potassium (NPK) fertiliser in this study. This study introduces a novel multifunctional fertiliser system by combining NPK, ZnO NPs, and NAA hormone, creating an integrated nutrient delivery approach that has not been reported previously. The incorporated ZnO NPs was synthesised by using a surfactant-assisted co-precipitation method, and were characterised by using SEM, XRD, FTIR, TEM, and DLS techniques, resulting in a moderate particle size of 222 ± 45.4 nm with spherical shape according to TEM analysis. Synthesised fertiliser hydrogels were characterised by SEM and FTIR analyses, confirming the successful encapsulation of nutrients into the hydrogel. The swelling capacity of fertiliser hydrogels was studied by immersing the beads in deionised water for a period of 21 days, which resulted in a peak swelling of 84% on the 14th day. The biodegradability of the beads was demonstrated by the soil burial method, resulting in a 98.23% weight loss of the beads at the end of the 20th day, which was further confirmed by microscopic observation of the buried beads. Zn and K content in fertiliser hydrogels was quantified using acid digestion followed by AAS, and mass percentages of the beads corresponding to K and Zn were reported as 10.0924%, 8.3253% respectively. Release studies of K and Zn were conducted by collecting aliquots at definite time intervals after immersing hydrogel beads in deionised water for 21 days, and analysing nutrient content in aliquots using AAS. Out of the encapsulated nutrients, cumulative percentages of 53.1548% K, and 2.1972% Zn were found as released at the end of experimentation period, demonstrating an extended-release pattern of nutrients. NAA release profile was studied using UV-visible spectroscopy depicted a burst-dominated release rather than an extended-release, with a percentage of 86.2314% encapsulated NAA released within 20 minutes, and then sustained at 2-4% after 25 minutes. The extended-release behaviour was concluded based on the nutrient release profile obtained from the synthesised fertiliser, where a gradual release of nutrients was observed over time due to the hydrogel-based matrix.

Keywords: *Fertiliser hydrogel, Biodegradable, ZnO nanoparticles, NAA, NPK fertiliser*

INVESTIGATION OF THE EFFECT OF EDTA INCORPORATION ON ZINC BLOOMING AND MECHANICAL PROPERTIES OF VULCANISED RUBBER UNDER ENVIRONMENTAL AGING CONDITIONS

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Bloom formation, particularly zinc stearate bloom, is a major surface defect in vulcanised natural rubber (NR) caused by the migration of zinc-containing species to the rubber surface during storage and environmental exposure. This phenomenon can negatively affect the appearance, adhesion, and durability of rubber products. To address this issue, ethylenediaminetetraacetic acid (EDTA) was investigated as a Zn^{2+} chelating agent for suppressing zinc stearate bloom in vulcanised NR dry rubber compounds. The study aimed to determine an optimal balance between EDTA, zinc oxide (ZnO), and stearic acid that could effectively reduce bloom formation while maintaining desirable curing and mechanical properties. Rubber compounds containing different levels of EDTA, ZnO, and stearic acid were prepared and vulcanised. The samples were subsequently subjected to environmental aging for 21 days under ambient temperature and humidity conditions to evaluate bloom development. Bloom behaviour was assessed through bloom rate measurements, while surface morphology and chemical characteristics were examined using scanning electron microscopy (SEM) and attenuated total reflectance Fourier transform infrared spectroscopy (ATR-FTIR). Mechanical testing was conducted to evaluate the effect of EDTA on material performance. The results demonstrated that EDTA effectively reduced zinc stearate bloom, although its performance was highly dependent on formulation composition. Among the formulations tested, the compound containing 1.0 (parts per hundred rubber) phr EDTA, 5.0 phr ZnO, and 2.0 phr stearic acid exhibited the greatest bloom suppression, showing the lowest bloom rate of $0.035 \pm 0.019\%$, compared with $0.116 \pm 0.012\%$ for the formulation containing 0.5 phr EDTA. SEM analysis revealed reduced surface crystallisation in formulations containing adequate EDTA, while ATR-FTIR spectra indicated suppression of zinc stearate formation through Zn^{2+} chelation. In contrast, formulations with insufficient EDTA or excess ZnO exhibited increased bloom formation due to incomplete chelation of zinc ions. EDTA was found to act as a mild cure retarder, resulting in increased scorch and optimum cure times; However, it did not significantly affect the overall mechanical properties of the vulcanised rubber. The findings suggest that optimized incorporation of EDTA is an effective strategy for mitigating zinc-induced bloom in vulcanised NR. This study highlights the importance of carefully balancing the EDTA: ZnO: stearic acid ratio to achieve improved surface quality while preserving curing characteristics and mechanical integrity.

Keywords: Natural vulcanised rubber, Zinc stearate blooming, EDTA, Surface stability, Environmental aging

DEVELOPMENT AND PERFORMANCE EVALUATION OF A POLYASPARTIC WOOD COATING AS AN ALTERNATIVE TO CONVENTIONAL POLYURETHANE COATINGS FOR COMMERCIAL SCALE USE IN SRI LANKA

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This study focused on the development, optimisation, and performance evaluation of a polyaspartic wood coating system as an alternative to conventional polyurethane (PU) coatings for wood finishing applications in Sri Lanka. Conventional PU coatings are widely used in the wood finishing industry due to their durability, gloss, and adhesion properties; however, they possess several limitations, including high volatile organic compound (VOC) emissions, moisture sensitivity, slow curing rates, and moderate mechanical performance. Therefore, this research aimed to develop a high-performance polyaspartic coating system with improved hardness, adhesion, chemical resistance, surface finish, and curing efficiency compared to a commercially available PU coating. The novelty of this work lies in the development and optimisation of a polyaspartic coating specifically for wood finishing applications and its performance evaluation against a conventional PU coating used in the local industry. The coating system was formulated based on the reaction between a secondary amine-functional polyaspartic resin and an aliphatic polyisocyanate hardener to form a highly crosslinked polyurea network. Initial formulations exhibited surface defects such as seeding, pinholes, orange peel texture, poor levelling, and reduced gloss. To overcome these issues, formulation optimisation was carried out using different defoamers, levelling agents, rheological modifiers, and propylene glycol monomethyl ether acetate (PMA). The optimised coating was then evaluated using pencil hardness testing (ASTM D3363), crosshatch adhesion testing (ASTM D3359), and chemical resistance testing (ASTM D1308). The developed polyaspartic coating demonstrated superior performance compared to the conventional PU coating. A pencil hardness value of 4H was achieved, compared to 2H for the PU coating, indicating enhanced scratch resistance resulting from the highly crosslinked polyurea structure. The coating also exhibited excellent adhesion with a 5B rating and showed excellent resistance to detergent solution, ammonia, tea, hot water, citric acid, and isopropyl alcohol, while permanent swelling was observed only after xylene exposure. In addition, formulation optimisation resulted in a smooth, defect-free, high-gloss coating with improved surface appearance. Overall, the findings demonstrate the potential of polyaspartic technology as a high-performance alternative to conventional PU coatings for wood finishing applications in Sri Lanka.

Keywords: *Wood coating, Polyaspartic coating, Polyurethane alternative, Coating optimisation, Evaluation*

ASSESSMENT OF SOIL CARBON SEQUESTRATION POTENTIAL ACROSS LAND USE TYPES IN THALANGAMA ENVIRONMENTAL PROTECTION AREA, SRI LANKA

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Thalangama Environmental Protection Area (EPA) is an urban wetland ecosystem which is situated in the Colombo District Sri Lanka. It has a great potential for soil organic carbon (SOC) storage and climate change mitigation. However, there are limited scientific studies on SOC sequestration rates across different land use types and soil depths in the wetland area. The present study aimed to determine SOC concentrations and stocks in five different land use types to investigate the SOC sequestration rates at various depths of different land use types. Major land use types identified in Thalangama EPA included tanks, cultivated paddy lands, abandoned paddy lands, mixed perennial lands, and residential areas. Soil samples were collected randomly from the 20–40 cm depth range using a soil core sampler at monthly intervals from June to October 2025, a period chosen to determine seasonal and hydrological fluctuations that influence soil organic carbon dynamics. The collected soil samples were air dried and processed for determination of soil bulk density and soil organic matter content and used to estimate SOC concentration and carbon stocks. The results showed significant spatial variation of SOC for the chosen land use types. Tank associated areas had the highest SOC stock (551.43 t/ha) showing the potential of wetland ecosystems for carbon retention under prolonged waterlogged conditions. In contrast, the lowest SOC stocks were found in abandoned paddy lands, which could be considered to the negative impact of land degradation and improper management practices on soil carbon sequestration. Tank-associated areas recorded notably higher SOC stock at 40 cm depth (158.74–551.43 t/ha), that can be driven by land-use management and hydro-geomorphic conditions. Overall, SOC distribution reflects strong control by land use and hydrology, making tanks important in wetland carbon sequestration in long-term. Among equivalent the categories of carbon sequestration potential, tank ecosystems recorded as the highest potential with an estimated 3034.80 t/ha CO₂ equivalent, while cultivated paddy lands recorded as relatively lower sequestration potential of 1577.73 t/ha CO₂ equivalent. Overall, the findings highlight ecological importance of protecting urban wetlands and restoring abandoned paddy lands and establishing climate-smart agricultural practices within the Thalangama EPA to enhance long term carbon sequestration and ecosystem sustainability.

Keywords: *Environmental protection area, Soil organic carbon, Carbon dioxide equivalent, Land use*

SUSTAINABILITY ASSESSMENT OF URBAN PARKS IN COLOMBO: AN INDEX-BASED APPROACH

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Colombo, as the largest metropolitan area in Sri Lanka, has undergone rapid demographic and spatial transformation, often characterised by high population densities, informal urban expansion, and limited availability of space. Within this context, urban parks serve as foundational components in the design of sustainable cities, as they are essential elements of urban infrastructure that provide a wide range of ecosystem services supporting social cohesion, economic vitality, and environmental quality. This study is justified as it responds to the urgent need to preserve and enhance the ecological, social, and economic functions of the city's parks in the face of ongoing urban pressures. By focusing on Viharamahadevi and Diyasaru urban areas, representing different typologies and management contexts, the research aims to develop a replicable, scientifically grounded sustainability index tailored to Colombo. The sustainability assessment framework was developed through a review of urban park sustainability literature (Gashu & Gebre-Egziabher, 2019). Data were collected through systematic field observations, visitor surveys (n = 160), and records obtained from park management authorities over six months. The questionnaire was pre-tested prior to data collection, and respondents were selected through random sampling across different park zones. Sixteen indicators with three main dimensions (environmental, social, and economic) have been identified. The computation of urban park sustainability has to take into account all three dimensions equally. In the calculation indicator values were standardised using a Min-Max normalisation method to transform data into a comparable scale ranging from 0 to 1. The overall sustainability indices calculated were 0.63 and 0.67 for Viharamahadevi and Diyasaru park, respectively, indicating that both parks have a moderate performance towards overall sustainability. The assessment revealed that environmental sustainability (0.78 for Diyasaru Park and 0.72 for Viharamahadevi Park) was the strongest dimension for both parks, supported by effective green space management and environmental education, while social dimensions (0.62 for Viharamahadevi Park and 0.59 for Diyasaru Park) showed adequate but improvable results in accessibility and recreation. Economic sustainability (0.63 for Diyasaru Park and 0.56 for Viharamahadevi Park) emerged as the weakest area, indicating a need for better revenue models and financial resilience. Equal weighting was applied to all three sustainability dimensions to ensure balanced representation of environmental, social, and economic aspects, although future studies may explore alternative weighting approaches. The comparative analysis highlighted the distinct strengths of each park and Viharamahadevi as a social and recreational hub and Diyasaru as an ecological and educational asset. These findings are consistent with studies from other rapidly urbanising cities, where environmental performance often exceeds social and economic sustainability outcomes. This study suggested that this approach can serve as a benchmark and decision-support tool for park managers, urban planners, policymakers, and communities.

Keywords: *Urban parks, Environmental sustainability, Social sustainability, Economic sustainability, Sustainable cities*



ENVIRONMENTAL AND RESOURCE ECONOMICS



INVESTIGATE THE FACTORS INFLUENCING CIRCULAR ECONOMY ADAPTATION BEHAVIOUR AMONG APPAREL SMALL AND MEDIUM ENTERPRISES IN PAMUNUWA, MAHARAGAMA

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Transition towards to circular economy from linear economy has become very critical due to the increasing level of resource depletion, waste generation and environmental degradation. Despite the global importance on circular economy practices, the actual adaptation among small and medium enterprises in developing countries remains limited. The objective of this study is to examine the determinants of circular economy adaptation behaviour among apparel small and medium enterprises in Pamunuwa, which is one of the biggest textile and garments trading cluster in Sri Lanka. Grounding from theories such as Theory of Planned Behaviour, Technology Acceptance Model, Institutional theory and Resource Based View, this study develops a model comprising of five independent variables which are environmental sensitivity, circular economy awareness, technology acceptance, adaptation readiness and organisational culture. In addition, it considers government policy pressure and short term goals perception as moderating variables. A quantitative research design was employed, and data were collected from 108 apparel small and medium enterprise owners/ managers in Pamunuwa through a structured questionnaire. Statistical analysis conducted using SPSS, including descriptive statistics, correlation, multiple regression, and moderation testing. The results of the study demonstrate that there is a significant effect of environmental sensitivity ($\beta = 0.407, p = 0.001$), organisational culture ($\beta = 0.529, p = 0.000$) and adaptation readiness ($\beta = 1.033, p = 0.000$) on circular economy adaptation behaviour, whereas the effect of circular economy awareness and technology acceptance on circular economy adaptation behaviours are not significant. Results from the moderation analysis shows that government policy pressure has a significant moderating effect on the relationship between technology acceptance and circular economy adaptation behaviour, as well as the relationship between adaptation readiness and circular economy adaptation behaviour. Moreover, short term goals perception significantly moderate the relationship between organisational culture and circular economy adaptation behaviour. The study demonstrates the influence of supportive organisational culture, readiness and effective policy implementation in driving circular economy practices for apparel small and medium enterprises in Pamunuwa. Finally, the study is valuable and insightful for policymakers and stakeholders when developing policies and strategies to achieve sustainable business transformation.

Keywords: *Circular economy, Circular economy adaptation behaviour, Environmental sensitivity, Organisational culture*

DETERMINANTS OF SUPPLIERS' PROMOTION OF CIRCULAR ECONOMY PRACTICES IN THE HARDWARE RETAIL SECTOR: EVIDENCE FROM COLOMBO DISTRICT, SRI LANKA

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The transition from a linear “take–make–dispose” economy to a Circular Economy (CE) has become increasingly important for promoting environmental sustainability and resource efficiency. This study investigated the factors influencing the extent to which suppliers promote Circular Economy principles and models within the hardware retail sector in the Colombo District of Sri Lanka. The study was grounded in the Theory of Planned Behaviour and examined the effects of retail owners’ consideration of CE principles, readiness to sell CE-friendly products, supplier encouragement, awareness of CE products, environmental sustainability knowledge, and perceived value of the linear model on supplier-driven CE promotion. In addition, the mediating role of hardware retail owners’ attitudes and the moderating effects of customer awareness and government policies were assessed. The target population comprised hardware retail owners in the Colombo District who procure products from suppliers implementing sustainability practices and Circular Economy principles. A snowball sampling technique was employed to access respondents within the sector. A target sample of 150 retail owners was established, and 128 valid responses were obtained for analysis. Primary data were collected through a structured, self-administered questionnaire containing Likert-scale items and open-ended questions. Data collection was conducted through online surveys, telephone interviews, and physical visits to ensure adequate response coverage. Data were analysed using the Statistical Package for the Social Sciences (SPSS). Reliability analysis, descriptive statistics, Pearson correlation analysis, and multiple regression analysis were used to examine relationships among variables. Mediation and moderation effects were tested using the PROCESS Macro with bootstrap resampling techniques. The findings revealed that retail owners’ consideration of CE principles, readiness to sell CE products, supplier encouragement, awareness of CE products, and environmental sustainability knowledge significantly and positively influenced supplier promotion of CE practices, while the perceived value of the linear model exerted a significant negative influence. Readiness to sell emerged as the strongest predictor of supplier-driven CE promotion. However, the mediating effect of retail owners’ attitudes and the moderating effects of customer awareness and government policies were not statistically significant. The study contributes to the emerging CE literature in developing-country retail contexts and provides practical implications for policymakers, suppliers, and retailers seeking to advance sustainability within Sri Lanka’s hardware sector.

Keywords: *Circular economy, Supplier promotion, Hardware retail, Sustainability, Sri Lanka.*

CONSUMER INTENTION TO ENGAGE IN EXTENDED PRODUCER RESPONSIBILITY (EPR) PRACTICES WITHIN THE FMCG SECTOR IN SRI LANKA

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The rapid growth of packaging waste generated by the Fast-Moving Consumer Goods (FMCG) sector has emerged as a critical environmental challenge in Sri Lanka, emphasising the urgent need for sustainable waste management solutions such as Extended Producer Responsibility (EPR). Although EPR has gained increasing global attention as an effective strategy for managing post-consumer packaging waste, limited empirical research has explored the factors influencing consumer participation in EPR practices within the Sri Lankan context. This study aims to examine the key determinants influencing consumer intention to engage in EPR practices in Sri Lanka's FMCG sector. A quantitative research design was adopted, and primary data was collected from 300 FMCG consumers aged 18 years and above using a structured questionnaire. Respondents were selected through purposive sampling from customers of Keells and Cargills supermarkets located along Bus Route No. 138 from Colombo to Homagama. This sampling approach enabled the inclusion of consumers with diverse demographic and consumption characteristics relevant to the study. The questionnaire consisted of five-point Likert scale items adapted from established literature. The study examined the effects of environmental attitude, subjective norms, collectivism, and perceived producer responsibility on consumer intention, while assessing the mediating role of perceived value and the moderating effects of contingency approach and government regulations. Data was analysed using IBM SPSS Statistics version 27 through reliability, descriptive, correlation, regression, mediation, and moderation analyses. The findings revealed that environmental attitude and subjective norms significantly influence consumer intention to engage in EPR practices. Perceived value significantly mediated the relationship between independent variables and consumer intention to engage in EPR practices, while government regulations and contingency approach significantly moderated this relationship. However, collectivism and perceived producer responsibility were not found to have significant direct effects. The model explained 57.5% of the variance in consumer intention. The study concludes that consumer engagement in EPR practices is primarily driven by environmental awareness, social influence, perceived value, and supportive regulatory mechanisms. The findings offer important implications for policymakers, FMCG producers, and environmental stakeholders by emphasising the need for strengthened environmental education, targeted awareness initiatives, and effective policy implementation to enhance sustainable packaging waste management and accelerate Sri Lanka's transition toward a circular economy.

Keywords: *Extended producer responsibility, Fast moving consumer goods, Consumer intention, Perceived value, Sustainability.*

DEVELOPMENT OF A SUSTAINABLE COCO PEAT BASED CAT LITTER

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Conventional cat litters are formulated primarily from bentonite clay or silica based granules. Although these materials are functionally effective, they pose significant environmental concerns due to their non-biodegradable nature, energy intensive mining operations and contribute to long term ecological degradation. The main objective of this research is to develop and optimise a biodegradable cat litter formulation. Specially, this aims to balance clumping ability, water absorption capacity and odour neutralisation with efficiency in production cost. In this study six formulations were prepared by varying the coco peat to corn starch ratio while maintaining constant amount of activated carbon (0.5 g) and citric acid (0.1 g). Clumping ability was quantitatively evaluated by simulating cat urine using water and conducting gravimetric sieving analysis. Water absorption capacity was calculated by weight change after saturation from water. Odour reduction performance was assessed through stoichiometric calculations using the amount of citric acid required to neutralise ammonia generated from urea hydrolysis. The results revealed that clumping performance decreased from 39.60 % to 26.72 %, with the reduction of corn starch composition from 2.7 g to 3.9 g, confirming that corn starch act as the primary binding agent in the formulation. In contrast, increasing the coco peat content from 5.5 g to 6.7 g enhanced water absorption capacity from 106.02% to 168.32%. due to the hydroxyl groups present in the cellulose fibres of coco peat. Among the tested formulations, formulation 5, consisting of 6.5 g of coco peat and 2.9 g of corn starch can be named as the optimal ratio of coco peat to corn starch for optimal water absorption rate and clumping efficiency at a competitive production cost. In conclusion, this research confirms that coco peat is a functionally effective and environmentally sustainable alternative to bentonite clay and silica based granules used in commercial cat litters. Furthermore, the developed formulation provides a scalable and low cost manufacturing of cat litter. The repurposing of agricultural waste into value added consumer products ensures the sustainability and eco friendliness of the developed cat litter product.

Keywords: *Sustainable, Biodegradable, Coco peat, Corn starch*



FOOD SCIENCE AND NUTRITION

DEVELOPMENT AND OPTIMISATION OF PLANT-BASED PROBIOTIC BEVERAGE USING PUMPKIN (*Cucurbita maxima*) PUREE WITH SOY MILK MATRIX

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Pumpkin (*Cucurbita maxima*) is a widely cultivated crop in Sri Lanka that experiences considerable postharvest losses and possesses valuable nutritional and potential prebiotic properties. On the other hand, the global demand for plant-based probiotic beverages is rising. Considering these aspects, this study aims to develop and optimise a plant-based probiotic beverage incorporating pumpkin puree (including peel) into a soy milk matrix. Preliminary trials standardised the processing parameters: 15% pumpkin puree, 0.2% xanthan gum, pasteurisation at 90 °C for 5 min, and fermentation with an ABT-5 mixed probiotic culture at 40 °C for 6 h to reach a pH of 4.4–4.6. A 3 × 3 factorial design was employed to evaluate the effects of soy milk and sugar concentrations on product quality and probiotic viability. Statistical analysis using two-way ANOVA identified a formulation containing 80% soy milk and 6% sugar as the optimal combination ($p < 0.05$). The optimised beverage was analysed for sensory characteristics (penalty analysis), proximate composition, physicochemical properties (pH, titratable acidity, total soluble solids, colour, viscosity), antioxidant activity (DPPH and ABTS), bioactive compounds (total phenolic and flavonoid content), mineral profile, probiotic stress tolerance (pH 2, pH 3, 0.3% bile salts), and microbiological stability under refrigerated storage (4 °C). Sensory evaluation revealed high consumer acceptability, with an overall acceptability score of 8.03 ± 0.80 on a 9-point hedonic scale. The beverage contained $90.35 \pm 0.52\%$ moisture, $3.52 \pm 0.08\%$ protein, and $2.37 \pm 0.45\%$ dietary fibre. Antioxidant activities determined by DPPH and ABTS assays were $27.94 \pm 0.52\%$ and $58.51 \pm 0.63\%$, respectively. Colour parameters (L^* , a^* , b^*) were 66.29 ± 0.20 , 7.28 ± 0.07 , and 33.35 ± 0.19 . Probiotic cells exhibited strong tolerance to acidic conditions (pH 2 and pH 3) and 0.3% bile salts. During refrigerated storage, probiotic viability remained above 9 log CFU/mL for 18 days, while coliforms and *Escherichia coli* were not detected. Statistical comparisons confirmed significant effects ($p < 0.05$) of formulation variables and storage duration on selected quality attributes. The findings demonstrate that pumpkin puree can serve as an effective functional substrate for developing a safe, acceptable, and nutritionally valuable plant-based probiotic beverage using soy milk as the carrier matrix without the addition of preservatives.

Keywords: Pumpkin, Probiotic beverage, Plant-based, Soy milk, Fermentation

ASSESSING THE CORRELATION OF QUALITY PARAMETERS AND EXOGENOUS ADULTERANTS / POLYPHENOLS WITH THE SENSORY PROFILE OF CEYLON BLACK TEA

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Ceylon tea is a globally well-known product that is very important to Sri Lanka's economy. However, commercially motivated adulterations such as the addition of materials like sugar and maltodextrin can enhance bulk or alter sensory qualities, which is a growing threat to its reputation. Although there are established instrumental methods to identify these adulterants, there is a crucial study gap about how these chemical additions affects human sensory experiences. This study investigates the association between typical adulteration characteristics and the sensory flavour profile of Ceylon black tea using an integrative strategy that combines expert sensory panel evaluations with rigorous chemical testing. Chemical tests were performed by using ISO standard methods and the Tea Research Institute-approved procedures. A tea tasting panel of two professional tea tasters analysed the dry leaf, infused leaves and tea liquor to detect whether the sample is adulterated or not. According to the test results, crude fibre content had a positive correlation with astringency and bitterness while alkalinity had a negative correlation with bitterness. Maltodextrin content showed a strong relationship with taste, aroma and sweetness while addition of sugar didn't show any significant relationship with sensory attributes. Pearson correlation analysis showed a moderate positive correlation between total ash and alkalinity ($r=0.512$) at the 90% confidence level. None of the contaminated samples fulfilled the ISO 14502-1-2005 standard minimum of 9% Total Polyphenol Content (TPC), according to chemical analysis. Adulterated samples showed considerably lower mean TPC values such as, high crude fibre detected samples ($3.645 \pm 1.934\%$), alkalinity-detected samples ($4.356 \pm 1.224\%$), and sugar-detected samples ($5.747 \pm 0.949\%$). This decrease is explained by a "dilution effect", in which the concentration of tea ingredients is lowered by non-phenolic fillers. Through comprehensive chemical and sensory screening, the results offer the Sri Lanka Tea Board a scientifically verified framework to improve quality control and protect the originality of Ceylon tea.

Keywords: *Ceylon black tea, Food adulteration, Sensory evaluation, Total polyphenol content*

PREDICTING SHELF-LIFE AND FUTURE VISUAL DECAY PROFILES OF GUAVA USING MULTI-ENVIRONMENTAL THERMAL-VISUAL IMAGE-BASED DEEP LEARNING

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Postharvest management of local white guava (*Psidium guajava*) is severely challenged by rapid metabolic shifts, which lead to significant commercial spoilage and nutritional losses. Traditional quality assessment method relies heavily on destructive testing or point-sensors that fail to capture whole-fruit physiological heterogeneity or adapt to supply chain environmental fluctuations. To address these limitations, this study introduces a non-destructive, multi-modal Deep Learning (DL) framework designed to predict the time elapsed from the full-matured stage, the remaining shelf-life until full-spoilage, and the synthesis of future visual damage profiles after t time. Two distinct Sample Sets (SSs): SS1 for model training and testing and SS2 for experimental validation, each set contain 5 fully matured and 50 damaged guava samples, were continuously monitored at 4-hour intervals until complete spoilage. To ensure model generalisation, data collection spanned three distinct environmental conditions: direct sunlight (30°C–40°C), ambient room temperature (20°C–30°C) and refrigeration (2°C–8°C). A Spatio-Temporal Sensor Fusion approach was implemented to merge internal metabolic heat signatures from thermal thermograms (UTi160S) with external surface characteristics captured via 50 MP visual imagery as inputs for the DL model. The DL pipeline was developed in Python 3.10 using TensorFlow and OpenCV for image transformation and model execution. Utilising transfer learning, 2D-CNN and Residual Network (ResNet) architectures were first trained on matured datasets to accurately label the existing stages of damaged fruit before final lifecycle modeling. The ResNet model demonstrated superior precision in tracking guava degradation. For remaining shelf-life prediction across all environmental conditions, ResNet achieved a training accuracy of 95.68% and a testing accuracy of 93.35% reliably mapping the transition from full-matured to full-spoilage. Crucially, while 2D-CNN tracked temporal metrics competitively, it failed to simulate future physical decay profiles, yielding just 66.59% training accuracy compared to ResNet's 90.04% in visual synthesis. Experimental validation (SS2) confirmed ResNet's stability with a 5-fold cross-validation Mean Squared Error of 0.0025. Conclusively, this thermal-visual ResNet framework accurately foresees guava spoilage patterns and shelf-life limits across diverse storage environments, offering a high-precision, non-destructive tool to mitigate global postharvest fruit losses.

Keywords: *Shelf-life prediction, Non-destructive quality assessment, Deep learning, Multi-modal sensor fusion, Future visual state synthesis*

PHYSICOCHEMICAL AND MICROBIOLOGICAL EVALUATION OF BALARISHTA DERIVED FROM DIFFERENT PRODUCTION BATCHES; TOWARDS STANDARDISATION

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Balarishta is a fermented, polyherbal Ayurveda formulation use for treat paralysis, nervous disorders, gastric disturbances, autoimmune diseases, and rheumatism. The quality, safety and efficiency of Balarishta are often influenced by variations in raw material, manufacturing practices, fermentation process, storage conditions, and microbial contamination. Scientific studies on the slandered specification of Balarishta has not been conducted previously. This study was conducted to evaluate the physiochemical and microbiological characteristics of Balarishta obtained from different production batches with the objective of determining whether significant batch-to-batch variations exist using statistical analysis. Four different production batches were collected and analysed for organoleptic, physicochemical, and microbiological properties using standard laboratory procedures and WHO guidelines for herbal medicine. Organoleptic characteristics such as color, odor, taste were evaluated, while physicochemical analysis include pH, specific gravity, total alcohol percentage, total sugar content, total solid content, refractive index and brix value. Microbiological evaluation comprised total bacterial count (TBC), total yeast and mold count (TYMC) and specific pathogenic bacteria. The formulations showed a characteristic sour taste with varying degrees of sweetness and a characteristic odor ranging from mild to pronounced intensity. The color variations ranging from light brown to dark brown. The statistical analysis was performed at a significance level 0.05 using independent -sample Kruskal-Wallis to evaluate batch to batch variation. Significant differences were observed among batches for all physicochemical parameters ($P < 0.05$) and TBC and TYMC across batches ($P < 0.05$). The total bacterial counts were within the limit according to the WHO guidelines ($< 10^5$ CFU/mL). However, the yeast and mold count of all four batches were over the limits according to WHO guidelines ($< 10^3$ CFU/mL). Pathogenic contamination was not detected in any batch. The study confirmed significant batch to batch variation available in physicochemical and microbiological parameters of Balarishta. This highlights the need for evidence-based quality control approaches towards standardisation to ensure quality, safety and therapeutic efficiency of the Balarishta.

Keywords: *Balarishta, Batch to batch variation, Physicochemical, Microbiological, Fermentation*



FORESTRY AND AGRICULTURE



**BIODEGRADABLE POLYMER-BASED SLOW-RELEASE FERTILISER
HYDROGEL FORMULATION: A SUSTAINABLE APPROACH TO ENHANCE
GROWTH, CHLOROPHYLL CONTENT AND YIELD OF TOMATO
(*Solanum lycopersicum*)**

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The world population is rising rapidly, and there is an increase in global food demand, which affects food security. Conventional fertilisers are widely used to increase agricultural productivity and ensure global food security. However, their excessive use negatively impacts the environment, as a large percentage is lost through leaching, degradation, and evaporation. In this context, biodegradable polymer-based slow-release fertiliser hydrogels (SRFHs) have emerged as promising materials for controlled nutrient delivery and improved agricultural sustainability. In this study, sodium alginate-carboxymethyl cellulose (SA-CMC)-based biodegradable SRFH enriched with NPK fertiliser, zinc oxide nanoparticles (ZnO NPs), and gibberellic acid (GA₃) was successfully synthesised and evaluated for its impact on the growth, chlorophyll content, and yield of tomato (*Solanum lycopersicum*). ZnO NPs were synthesised via the co-precipitation method. Synthesised SRFHs were characterised through SEM and FTIR techniques. The swelling study showed that the SRFH beads reached a maximum swelling capacity of 90.66% on day 14, which was significantly higher than that of the SA-CMC polymer-only hydrogel beads. The biodegradability study demonstrated that the hydrogel beads underwent rapid degradation with 95.82% weight loss within 20 days, confirming their ecofriendly and biodegradable nature. These findings were further supported by optical microscopic images, which showed progressive structural disintegration of the beads during the soil burial period. UV-VIS spectrophotometry was used to study the release behaviour of GA₃ hormone and depicted a sustained release profile for the observed duration of 21 days. Kinetics of the exponential phase of the GA₃ release profile, which was between 20 and 450 minutes, well matched with the Higuchi model with an $R^2 = 0.97$. Atomic absorption spectroscopy (AAS) was used to quantify Zn and K nutrient content and to study their release profiles at 24-hour, 7 day, 14-day, and 21-day intervals. The results confirmed the successful encapsulation of nutrients and their sustained slow-release behaviour over time. Plant assessment was conducted using tomato plants, where parameters including plant height, number of branches, number of flowers, number of pods, and chlorophyll content during flowering and fruiting stages were analysed and statistically significant results were observed, along with the corresponding p values. Significant enhancement in overall plant growth demonstrated the effectiveness of the synergistic interaction among encapsulated NPK nutrients, ZnO NPs, and GA₃. With its ability to improve nutrient use efficiency, reduce environmental pollution, and enhance crop productivity, the synthesised biodegradable SRFH presents a promising and environmentally responsible alternative to conventional fertiliser systems in modern agriculture.

Keywords: Biodegradable hydrogel, Slow-release fertiliser, Sodium alginate-carboxymethyl cellulose biopolymers, Sustainable agriculture



GLOBAL DATA EFFICIENCY

AI-DRIVEN RESOURCE ALLOCATION

AI-DRIVEN RESOURCE ALLOCATION

GREEN COMPUTING STANDARDS

SUSTAINABLE ALGORITHM OPTIMIZATION

Energy-Efficient Data Routing

Resource Allocation

GREEN NETWORK TOPOLOGY

INFORMATION TECHNOLOGY AND COMPUTING

A WEB-BASED EXPLAINABLE CNN-LSTM PROTOTYPE FOR SLEEP APNEA REVIEW USING EEG AND EOG SIGNALS

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Sleep apnoea is a breathing disorder which can affect sleep quality and has long-term health risks. The most common clinical technique for diagnosis is polysomnography, but interpretation of complete overnight recordings can be time-consuming, and is typically performed by a specialist. This study proposed a prototype of an explainable deep-learning based web system to review sleep-apnoea predictions with electroencephalography (EEG) and electrooculography (EOG) signals. The main data used was ISRUC-Sleep. EEG/EOG channel selection, filtering, normalisation, compatibility handling and segmentation into 30 seconds epochs were prepared for the recordings. A convolutional neural network-long short-term memory (CNN-LSTM) model with temporal attention was used to train the model for epoch-level apnoea classification, with the use of a different model setting during the evaluation process. The final subject-wise model was chosen due to its best apnoea-oriented performance among the tested ISRUC models. It had an accuracy of 0.818, an apnoea precision of 0.144, an apnoea recall of 0.320, an apnoea F1-score of 0.198, and a receiver operating characteristic area under the curve (ROC-AUC) of 0.668 at the selected operating point. Further experiments at UCD (University College Dublin) revealed dependency on the dataset and resulted in mean test ROC-AUC of 0.561 and tuned F1-score of 0.334. The overall accuracy was satisfactory, but the apnoea-class F1-score was low because of false positive and false negative, and class imbalance and sensitivity of the datasets. This trained model was embedded in a Streamlit prototype for uploading recordings, choosing EEG/EOG channels, reviewing predictions, inspecting predictions at an event level, handling sessions, view explanation and export reports. Selected epochs of EEG/EOG were used to examine temporal regions of attention, salience, integrated gradient and SHapley Additive exPlanations (SHAP) to help review uncertain or incorrect predictions. The system is thus considered to be a prototype for research-based decision support system rather than a ready-to-use clinical diagnostic system. Future research should enhance apnoea-class performance with class-weighted loss, focal loss, resampling, more data and better cross-dataset validation.

Keywords: *Sleep Apnea detection, EEG, EOG, Explainable AI, Decision-support prototype*

MULTI-INPUT CROP AND FERTILISER RECOMMENDATION SYSTEM FOR ENHANCED AGRICULTURAL PRODUCTIVITY

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The agriculture sector is very important in Sri Lanka and is a key sector for food security, as well as for rural livelihoods. Most current recommendations for crop and fertiliser management are, however, based on average recommendations which do not account for differences in soil and environmental conditions within a field. Soil nutrient status, soil pH, moisture and rainfall, and soil temperature can all have a significant effect on crop performance, with use of broad recommendations likely to lead to inappropriate choice of crop, inefficient use of fertiliser, yield loss, higher production costs, and environmental damage. To overcome these limitations, an intelligent decision support system known as Multi-Input Crop and Fertiliser Recommendation System (MICFRS) is proposed here, which combines three approaches: (1) Machine Learning (ML) for accurate recommendations, (2) Rule-based validation for interpreting the results, and (3) Retrieval-Augmented Generation (RAG) to enhance the explainability of the recommendations by explaining to farmers the reasons behind the suggested actions. The goals of the study are to identify proper crops in accordance with soil and environmental conditions, to recommend proper fertilizers and to give explanation that is clear and transparent for agricultural decisions. The system was developed using agricultural data which includes soil parameters like moisture, pH, nitrogen (N), phosphorus (P), potassium (K) and environmental attributes like temperature, rainfall, humidity etc. To develop the model, various machine learning algorithms were tested, such as Decision Tree, Gradient Boosting and Random Forest. After hyperparameter optimisation and cross validation, the best overall performance was found in Random Forest and was chosen as the final prediction model. One of the major contributions of MICFRS is the embedding of RAG in the process of recommendations. The RAG component leverages a FAISS-based retrieval mechanism to fetch relevant agricultural information, growing instructions, nutrient management, and fertiliser recommendations from trustworthy sources, unlike traditional recommendation systems which merely provide predictions. This allows the system to offer intuitive explanations, increase transparency and boost the trust of users in the recommendations made. The results from the experiments showed promising predictive capabilities. The crop prediction model had accuracy of 92.26%, precision of 92.39%, recall of 92.26% and F1-score of 92.28% while the fertiliser recommendation model had accuracy of 78.57%, precision of 78.15%, recall of 78.57% and F1-score of 78.24%. The benchmarking results also demonstrated that the system of MICFRS was better than other similar recommendation systems. In conclusion, the proposed system offers a feasible option for precision agriculture, aiding in informed decision-making, effective fertiliser management, enhanced productivity, and sustainable farming practices in Sri Lanka.

Keywords: *Crop recommendation, Fertiliser recommendation, Machine learning, Retrieval-augmented generation, Precision agriculture*

PULSEFIT: INTEGRATED MACHINE LEARNING FRAMEWORK FOR PERSONALISED CALORIE PREDICTION, WORKOUT RECOMMENDATION, AND DIET ENHANCEMENT

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Fitness tracking is currently disjointed, with users using different apps to count calories, get workout advice and meal plans. This dichotomy hinders personalisation and the integration of exercise, energy consumption and nutrition in a single decision making process. This research introduces PulseFit, a unified machine learning system to personalise calorie estimation, workout recommendation, and diet optimisation. The system was implemented using a three-tier architecture with React, HTML, and CSS for the frontend; FastAPI and Python for the backend; and scikit-learn, FAISS, LangChain, pandas, and NumPy for the machine learning and recommendation components. Data was stored in PostgreSQL and the development was done using Visual Studio Code and Jupyter Notebook. The calorie prediction component is based on a GradientBoostingRegressor model trained with the Gym Members Exercise Tracking Dataset, a dataset that includes around 20,000 records with physiological and workout related information like average heart rate, resting heart rate, maximum heart rate, heart rate recovery percentage, workout type, duration of the session, resting rate, age, height, weight, BMI and so on. Exercise metadata was represented as structured data and stored in a separate structured dataset, which was also indexed with a FAISS store for retrieval-augmented generation (RAG) of workout suggestions, while meal data was represented as nutrition data and stored in another structured data store, again indexed with a FAISS store for nutrition-based meal suggestions. The calorie prediction model had a Mean Absolute Error (MAE) of 119 kcal, which shows good prediction performance, and R^2 of 0.839. The RAG-based recommendation modules performed well, staying within $\pm 15\%$ of target values with a fallback rate of just 5% when the LLM service was unavailable, and an average response time of 2-3 seconds per API call. To validate the system, the expert evaluation was carried out on five domain experts (gym trainers and fitness professionals) and five technical experts (data scientist and senior software engineers). The accuracy of the calorie predictions, the quality of the explanations generated by RAG and the overall usability of the system were all emphasised by experts. A focus group test additionally verified that the system's features were intuitive, and its suggestions were relevant to their exercise objectives. Medical and fitness domain expertise was integrated by means of structured expert evaluations of the workout and meal suggestions, and the health professionals that evaluated their outputs confirmed that the outputs were contextually suitable and clinically reasonable for a healthy adult user population.

Keywords: *Calorie prediction, Workout recommendation, Meal planning, Machine learning, Gradient boosting*

SCAFMIND: PROGRESSIVE SCAFFOLD WITHDRAWAL FOR AUTONOMOUS REASONING IN LARGE LANGUAGE MODELS

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Large language models (LLMs) frequently exhibit brittleness in multistep reasoning despite their fluency. Existing studies predominantly rely on static chain-of-thought (CoT) prompting during inference; however, this over-reliance inadvertently creates an "addiction to hints." Because models do not internalise the underlying cognitive logic, their autonomous reasoning capabilities degrade significantly once these prompts are removed. To overcome the limitations of traditional CoT approaches, ScafMind was developed as a progressive curriculum learning framework that gradually reduces guidance. This system utilises a Meta LLaMA-3 8B model enhanced with Quantised Low-Rank Adaptation (QLoRA) and 4-bit quantisation. After initial training on three cognitive benchmarks (GSM8K, StrategyQA, and LogiGLUE), the framework applies controlled stochastic Bernoulli masking via a DynamicScaffoldCollator. During training, this mechanism dynamically generates four scaffold levels, ranging from full guidance (Level 3) down to zero guidance (Level 0), while rigorously maintaining ground-truth target labels. A bespoke process-isolation orchestration pipeline facilitated the training of nine models across three methodologies (ScafMind, Static CoT, and Vanilla) without memory degradation. Model performance was evaluated in a zero-shot setting without inference-time scaffolds using Exact-Match (EM) accuracy, Wilson confidence intervals, McNemar's test, and a novel Scaffold Dependency Score (SDS). Experimental results indicate that under zero-shot evaluation, ScafMind outperformed the Static (52.84%) and Vanilla (53.06%) baselines, achieving a 58.08% EM accuracy on StrategyQA with statistical significance ($p=0.0241$). Furthermore, ScafMind attained an SDS of +8.65 on StrategyQA, indicating a true reasoning retention rate of 91.35% following complete scaffold withdrawal. On the GSM8K mathematics dataset, ScafMind demonstrated a substantial 113.95% relative improvement over the Static baseline in zero-shot conditions. Ultimately, this framework unequivocally establishes that incremental scaffold removal through curriculum learning significantly enhances autonomous, zero-shot reasoning in resource-constrained language models, although LogiGLUE outcomes highlighted the architectural capacity limitations of an 8B model on highly complex spatial problems.

Keywords: *Large language models, Scaffolded learning, Scaffold dependency score, Chain-of-thought Prompting, Progressive curriculum learning*

MULTIMODAL HYBRID FUSION FOR REAL-TIME EMOTIONAL MASKING DETECTION IN AI MENTAL HEALTH SCREENING

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Existing text-based mental health screening tools are fundamentally limited by their unimodal design, rendering them unable to detect emotional masking, a phenomenon where individuals verbally report positive wellbeing while exhibiting nonverbal distress. This vulnerability is particularly acute in high-stigma cultural contexts such as Sri Lanka, where social pressure compels concealment of genuine psychological distress, leading to dangerous false-negative assessments in automated screening systems. This research addresses this critical gap by designing, implementing, and validating a low-latency Multimodal Hybrid Fusion (MHF) system following a three-tier asynchronous architecture. The browser or client tier processes raw video frames locally using face-api.js to extract facial emotion labels and confidence scalars, ensuring that only non-biometric scalar values cross the network boundary to the backend tier, thereby guaranteeing privacy-by-design compliance. The backend tier, implemented in FastAPI with ASGI compliance, hosts an optimised DistilBERT model for natural language processing, exported to ONNX Runtime for accelerated inference. A server-side circular deque buffer maintains a five-second sliding window of facial emotion states, enabling temporal synchronisation of asynchronous HTTP text submissions and continuous WebRTC video streams immediately before data enters the omega conflict decision layer. This formally defined mathematical rule detects intermodality contradictions and dynamically reallocates fusion weights to 0.75 for facial emotion and 0.25 for text during conflicts, whilst applying balanced 0.5 and 0.5 weighting in non-conflicting scenarios. Evaluation against a unimodal text-only baseline demonstrated that the NLP classifier achieved precision of 0.81, recall of 0.84, and an F1 score of 0.824, whilst the complete MHF system attained an F1 score of 0.890, representing an 8.0% absolute improvement that exceeded 20% on targeted masking simulations. End-to-end analytical latency averaged 342 ms, comfortably within the 500 ms threshold. The system establishes a validated architectural blueprint for privacy-preserving real-time multimodal affective computing in mental health screening applications.

Keywords: *Multimodal AI, Emotional masking, Mental health screening, Hybrid fusion, Real-time inference*

PREDICTIVE AND PRESCRIPTIVE RISK MANAGEMENT IN AGILE PROJECTS: AN EXPLAINABLE AI (XAI) FRAMEWORK FOR SPRINT LEVEL ROOT CAUSE PRIORITIZATION

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Despite having the latest project management tools (Jira, Azure DevOps, Trello), as well as sophisticated intelligent technologies in automation and pattern recognition, Agile teams continue to struggle to identify project risks in time and make effective decisions to address them. Over 55% of project risks remain undetected until they negatively affect delivery outcomes according to previous research studies. Existing tools predominantly offer static and manually maintained risk logs, but they are unable to learn from historical sprint patterns, prioritise risks, and provide meaningful explanations to help project managers in making informed decisions. To overcome these limitations, this research aims to develop and validate an Explainable Artificial Intelligence (XAI) based framework for sprint level risk identification and deliver transparent, ranked risk prioritisation guidance based on SHapley Additive exPlanations (SHAP) feature attribution. The research methodology consists of five stages: dataset preparation, predictive model development, XAI integration, risk prioritisation framework construction, and evaluation. The dataset utilised in the study is the TAWOS (Tawosi Agile Web-based Open Source) dataset with over 508,000 of the issue records gathered from 39 open- source Agile projects. From this dataset, 21 sprint level features (technical, process and human) were extracted, risk labels were assigned with the help of percentile-based classification strategy and 38.8% (2,804) of the sprint records were identified as high risk. Four machine learning algorithms, Logistic Regression, Random Forest, XGBoost and Support Vector Machine, were trained and tested. Of these, the best predictive results were obtained by XGBoost with Area Under the Receiver Operating Characteristic Curve (AUC-ROC) of 0.9451, accuracy of 86.27% and F1-score of 0.8246. A SHAP analysis was performed to figure out the most important factors affecting sprint risks. The results showed that the most significant risk drivers were bug ratio, effort overrun and frequent team reassignments. The proposed structure provides a clear and understandable risk management framework that helps to close the gap between predictive performance and real-world Agile project planning.

Keywords: *Project risk management, Explainable artificial intelligence (XAI), Risk prediction, Risk prioritisation*

A SEMI-SUPERVISED LONG SHORT-TERM MEMORY AUTOENCODER WITH SHAPLEY ADDITIVE EXPLANATIONS FOR REAL-TIME PROGRESSIVE WEB APP PERFORMANCE MONITORING

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While Progressive Web Applications (PWAs) require native-like user experiences, current AI-powered performance monitoring solutions are like "black boxes". There are existing methods such as standard Long Short-Term Memory (LSTM) and Shapley Additive Explanations (SHAP) but they are not efficient enough for real-time edge deployments. To tackle this research gap, this study suggests an Explainable Artificial Intelligence framework (XAI-PWA-Perf) that offers real-time anomaly detection alongside computationally economical diagnostic information. The methodology presents a semi-supervised Autoencoder technique that uses a Hybrid LSTM neural network model which is trained using only healthy application performance streams. One of the main novelties of this paper compared to previous work is the embedded trigger based DeepSHAP architecture that uses a gradient based layer and is only activated when the reconstruction error from the model falls above the run-time anomaly threshold. This threshold (here, 0.000297) was dynamically set during baseline training such that it optimises the edge inference profile with less than 50ms of processing latency when using the maximum mean absolute error (MAE) from the validation set. Using automated Playwright scripts, we collected 11,530 telemetry samples, including Core Web Vitals (LCP, FID, CLS), Total Blocking Time (TBT), CPU usage, and memory usage, with a headless version of the Chromium browser. While the framework is initially based on a programmatic defect injection method to generate a ground truth set of defects, it is generalised using standard W3C Web Performance APIs which makes it robust and applicable to real world performance problems in a wide range of PWA architectures and deployment contexts. The proposed model achieved an outstanding diagnostic precision of 0.90, a recall of 0.99 and an F1-score of 0.95. The LSTM-Autoencoder outperformed other baseline anomaly detection approaches in accurately identifying and assigning specific metrics, such as CPU depletion events, to high error rates, especially for complex temporal data interactions. The co-engineered framework ultimately addresses the monitoring performance/transparency dilemma, enabling engineering workflows to use diagnostic reasoning that is accessible and made available through a dashboard, not in the form of a generic failure notification.

Keywords: *Anomaly detection, Explainable AI (XAI), LSTM-Autoencoder, Performance monitoring, Progressive web application (PWA)*

AST-BASED EXTRACTION OF ANGULAR CODE STRUCTURES FOR AUTOMATED DOCUMENTATION GENERATION

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In fast-changing Angular applications, component, service, module and other Angular-specific features are constantly changing, which makes it difficult to maintain accurate documentation of the software during development. The present work proposes an Abstract Syntax Tree (AST)-based extraction system for automated framework-aware documentation generation specific to an Angular application. Although the AST-based documentation approaches have already been investigated, few tools address the generic code structure or are based on manual execution and static snapshot. The proposed framework identifies Angular-specific constructs like decorators, dependency injection patterns, lifecycle hooks, JSDoc annotations, and Angular 17+ signal-based constructs and also synchronises with documentation in real-time, unlike traditional documentation generators. The research followed the Design Science Research methodology, including requirements analysis, design, prototype implementation, and evaluation. The ten open-source Angular repositories were analysed to collect the requirements. The prototype was implemented in TypeScript with the TypeScript Compiler API, the ts-morph library, and a rule-based extraction engine for the generation of structured representations of metadata. Six source files for Angular were used in initial validation. In order to further validate the evaluation, an additional validation experiment was performed with 10 Angular developers against 50 source files from real-world Angular projects. The evaluation demonstrated complete coverage of the documentation-relevant Angular entities identified through AST analysis across the evaluated source files. Performance measures indicated that AST parsing time was 1-5ms per file, entity extraction time was 0-3ms per file, and rule evaluation time was 3-11ms per file, and total processing time was 5-19ms per file, which is still below the 100ms human-perception threshold. The framework effectively addresses the needs to capture the semantics of Angular applications, which is not possible with conventional documentation generators, and generic approaches with LLMs, while offering a lightweight, offline, and extensible toolset for real-time automated documentation. Future work will extend the evaluation across larger repository collections and support additional front-end frameworks.

Keywords: *Angular, AST parsing, Automated documentation, Documentation synchronisation, Live documentation*

EXPLAINABLE PERSONALISED SPACED REPETITION SYSTEM FOR LANGUAGE LEARNING

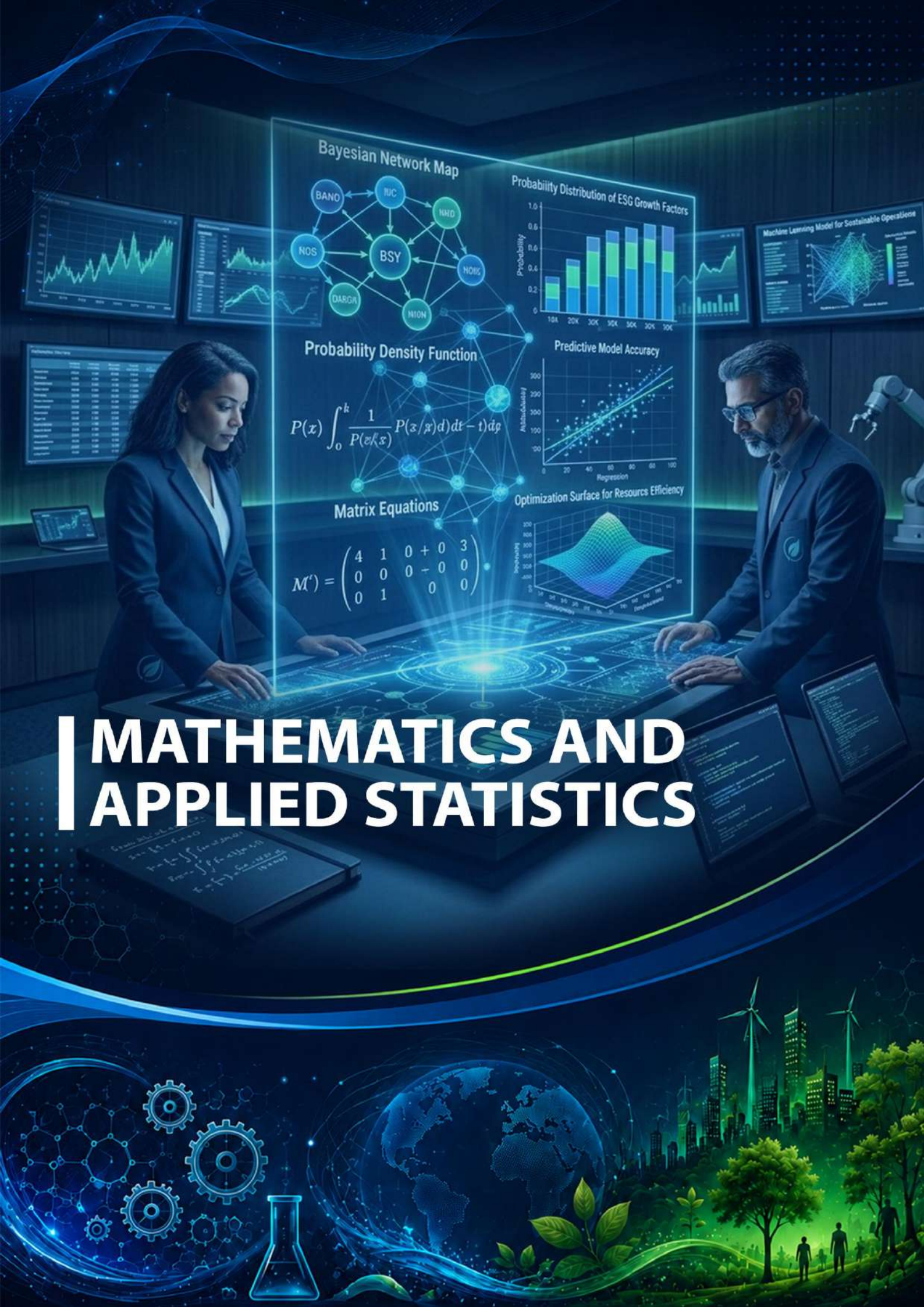
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Vocabulary retention is a continuing challenge in second-language learning, particularly when review activities are not scheduled according to individual forgetting patterns. Existing spaced repetition systems used in language-learning platforms can recommend when learners should revise vocabulary, but they often provide limited explanation of why a particular word is selected for review. This reduces transparency for learners and limits the evidence available for teachers to understand learner progress. This study presents XMemLang, an explainable personalised spaced repetition approach designed to predict vocabulary recall and provide interpretable reasons behind review recommendations. The study used a filtered subset of the Duolingo Spaced Repetition Dataset containing 221,661 learner-word interactions across anonymised learners, vocabulary lexemes and language-learning records. Learner history, review delay, previous correctness, session-level performance, user-level behaviour and word-level difficulty features were engineered based on memory-retention theory and validated through model comparison, feature-importance analysis and SHAP-based interpretation. Half-Life Regression was used as the main spaced repetition baseline, while Random Forest, LightGBM and XGBoost and ensemble variants were evaluated because of their suitability for structured educational interaction data and their ability to model nonlinear relationships between learner behaviour and recall outcomes. To reduce overfitting and data leakage, the experiments used a user-grouped train-validation-test split with no user overlap between partitions, together with cross-validation and generalisation checks. The tuned XGBoost model achieved MAE = 0.044, RMSE = 0.094, log-loss = 0.116, AUC = 0.999 and accuracy = 97.79%, compared with the Half-Life Regression baseline, which achieved MAE = 0.138, RMSE = 0.291, log-loss = 0.405, AUC = 0.731 and accuracy = 91.01%. Although the results show a clear improvement over the baseline, the high AUC was interpreted cautiously, with user-grouped validation, cross-validation and train-validation-test generalisation checks used to reduce overfitting and data leakage risk. SHAP explanations indicated that session accuracy, review delay, word difficulty, word bias and user skill were the most influential factors affecting recall prediction. These explanations can be converted into learner-friendly feedback, such as recommending earlier review when a word has a long review delay, low past accuracy or higher difficulty. The proposed approach can support language-learning platforms by combining prediction, adaptive scheduling and transparent feedback, while learner and teacher feedback supported simple explanations and dashboard-based insights. Ethical considerations include anonymisation, secure handling of learner interaction data and responsible use of personalised recommendations. The findings suggest that explainable AI can improve spaced repetition by making vocabulary review more personalised, transparent and educationally meaningful.

Keywords: *Spaced repetition, Second language learning, Recall prediction, Personalised learning, Explainable AI*



Bayesian Network Map



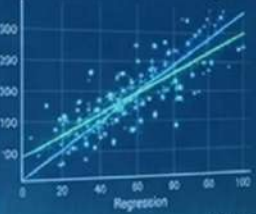
Probability Distribution of ESG Growth Factors



Probability Density Function

$$P(x) \int_0^k \frac{1}{P(x/x)} P(x/x) dt - t) dx$$

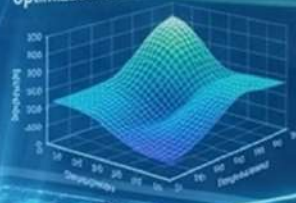
Predictive Model Accuracy



Matrix Equations

$$M' = \begin{pmatrix} 4 & 1 & 0 & 0 & 3 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \end{pmatrix}$$

Optimization Surface for Resource Efficiency



MATHEMATICS AND APPLIED STATISTICS



DEVELOPING A DECISION SUPPORT SYSTEM FOR PHARMACEUTICAL PRODUCTION PLANNING USING LINEAR PROGRAMMING

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Pharmaceutical production planning is challenging with fixed batch sizes and volatile monthly demand due to machine capacity limitations and Good Manufacturing Practices (GMP). At ABC Company (Pvt) Ltd, Sri Lanka, monthly demand is converted into required batch numbers, often yielding fractional values. Since fractional batches cannot be produced, these numbers are manually rounded up (ceiling) or rounded down (flooring). In the existing manual process, planners relied exclusively on simple ceiling or flooring without any verification of raw material availability. Continuous ceiling leads to overproduction and accelerated raw material depletion, while consistent flooring causes shortages and unmet demand. To address these limitations, this study developed a Decision Support System (DSS) based on a Linear Programming (LP) optimization model. The objective is to maximize total batch production subject to raw material availability and per-batch material requirements. The DSS automatically calculates the required batch quantity from monthly demand, and the LP optimization determines the maximum number of batches that can be produced from current raw material inventory, effectively establishing a feasibility upper bound for each product. The model was initially formulated and validated in MATLAB, then deployed as a user-friendly, web-based dashboard using Python's Streamlit library. The DSS provides five rounding strategies (ceil, ceil+1, floor, floor-1, direct entry) for the LP results, along with real-time verification of raw material sufficiency. Unlike the manual approach, which applied only ceiling or flooring with no feasibility check, the DSS evaluates each production decision against the LP-derived maximum and automatically identifies critical raw materials before plans are finalised. Validation using real production data from ABC Company demonstrates that the DSS significantly reduces both excess production and shortages compared to the existing manual planning approach, while also pinpointing the critical raw materials that constrain production. This enables more balanced and inventory-conscious planning. When the planned production quantity cannot be supported by available raw materials, the system issues a warning, lists the limiting materials, and displays the exact shortfall. Conversely, when sufficient materials are available, the system confirms production feasibility. The dashboard further provides monthly planning summaries, displays the planned production quantity for each product, and tracks detailed inventories of both finished goods and raw materials, supporting more effective monitoring of production performance and resource utilisation.

Keywords: *Optimisation, Linear programming, Decision support system, Pharmaceutical production planning*

AN ANALYTICAL STUDY ON REDUCING METAL WASTE IN THE STEEL WHEEL MANUFACTURING PROCESS

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Metal waste generation has become a major concern in steel wheel manufacturing due to its impact on production cost, material utilisation, and environmental sustainability. Within the Wheel Manufacturing Division of Michelin Lanka (Pvt) Ltd., significant quantities of metal waste are generated during cutting, machining, forming, and finishing operations. This study was conducted to analyse the existing waste generation pattern and develop optimisation-based approaches to reduce metal waste in the steel wheel manufacturing process. The primary objective of the study was to improve material utilisation by identifying critical waste generating areas and proposing suitable optimisation strategies for waste minimisation. A quantitative and analytical research approach was adopted using operational data collected from the Wheel Manufacturing Division for the year 2025. Pareto analysis was used to identify the most significant waste categories and the production cells contributing the highest waste volumes. Based on the analysis, metal offcut waste was identified as the dominant waste category. Two optimisation models were developed to address the identified waste generation processes. A Two-Stage Cutting Stock Model based on Mixed Integer Linear Programming (MILP) was developed to optimise strip cutting operations, while an Area-Based Allocation Model using a Greedy Heuristic approach was developed for nave profiling operations involving complex geometric layouts. The models were implemented using Python programming language. The results demonstrated substantial improvements in material utilisation and waste reduction. The MILP-based cutting stock model reduced strip offcut waste by a reduction of 43.93%, while plate usage for strip production was reduced by 18.86%. The heuristic-based allocation model reduced nave offcut waste by a reduction of 52.61%, with an 8.23% reduction in plate usage. Through the application of integrated optimisation methods, the total offcut waste was decreased by 46.31% and the total metal waste by 28.26%. Also, the IQP% value shifted from 19.3% to 13.85%, which shows that production efficiency and material utilisation reached a superior level. The research outcomes verify that optimisation-based and data-driven approaches can lower waste generation in industrial manufacturing systems in a significant way. Because the exact optimisation methods are combined with heuristic techniques, the research demonstrates that practical and effective solutions for different manufacturing conditions are established. The operational efficiency, manufacturing cost, and sustainable production practices in steel wheel manufacturing are supported by these research findings.

Keywords: *Metal waste, Steel wheel manufacturing, Optimisation, Cutting stock model, Material utilisation*

EFFECTS OF PERFORMANCE APPRAISAL SYSTEM ON EMPLOYEE ATTITUDE AND WORK PERFORMANCE OF NATIONAL WATER SUPPLY AND DRAINAGE BOARD

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Performance appraisal systems are fundamental to improving employee motivation, performance, and organisational effectiveness. When such systems are seen as ineffective, unfair, or non-transparent, they risk negatively shaping employee attitudes and work performance. While performance appraisal is well-researched in private sector contexts, public sector institutions in Sri Lanka, including the National Water Supply and Drainage Board (NWSDB), remain underexplored. This study investigated the effects of performance appraisal practices on employee attitude and work performance at the NWSDB. A quantitative design was adopted, with data gathered through a structured questionnaire from 242 NWSDB Head Office employees spanning higher, middle, and junior management levels, and management assistants, selected via proportionate stratified random sampling. Five constructs were examined: appraisal system effectiveness, fairness and transparency, feedback and communication, employee attitude, and work performance. Cronbach's Alpha and Pearson correlation were used to assess reliability and validity. Structural Equation Modelling (SEM) through AMOS software tested relationships among constructs and the mediating role of employee attitude. Descriptive results showed positive employee perceptions across all appraisal dimensions, with mean scores above the neutral midpoint. The structural model yielded an acceptable fit (CMIN/DF = 2.440, RMSEA = 0.077, GFI = 0.887, CFI = 0.930, TLI = 0.918, NFI = 0.898). All three independent constructs, namely appraisal effectiveness, fairness and transparency, and feedback and communication, significantly shaped employee attitude, with feedback and communication recording the strongest influence. Feedback and communication further showed a direct effect on work performance. Appraisal effectiveness and fairness and transparency had no significant direct effects on work performance, but their indirect effects, mediated through employee attitude, were statistically significant. Employee attitude proved to be both a strong predictor of work performance and a meaningful mediator between appraisal practices and performance outcomes. The study confirms that performance appraisal practices considerably shape employee attitudes and performance at the NWSDB. Improving feedback quality and appraisal transparency are recommended as priority areas. Since the study was limited to the NWSDB Head Office, generalisability remains constrained, and future research should engage multiple public sector organisations to strengthen broader applicability.

Keywords: *Performance appraisal, Employee attitude, Work performance, Structural equation modelling*

A GRAPH THEORETICAL FRAMEWORK FOR E-COMMERCE UI OPTIMISATION USING THE RETAILROCKET DATASET

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Optimised UI (User Interface) design paves the way for profit maximisation of E-commerce platforms, and graph theoretical concepts can be used successfully for that purpose. The objective of this study is to apply graph theoretical concepts for UI design optimisation to identify navigational bottleneck pages and suitable product category groups using the ‘Retailrocket Recommender System’ dataset. The dataset was collected in 2015 and may not fully reflect current customer behaviours in 2026, but the graph-theoretic methodology remains as a valid framework applicable to clickstream data of E-commerce platforms. User navigations were modeled as a directed weighted graph with vertices representing unique products, edges representing user-transitions between products, and weights calculated using the number of transitions between corresponding products. The product page with item identification number 119736 was identified as the top navigational bottleneck, which has the highest betweenness centrality value of 106,476 (median = 1,243). The community detection algorithm identified 61 communities in the constructed graph using the Louvain method. To optimise the UI design, predictive breadcrumbs and sticky ‘next steps’ sidebars can be added for bottleneck pages. Restructuring mega-menus to merge groups of products that users almost browsed together with the knowledge of identified communities will improve the user experience. This study shows that a graph theoretical framework can be successfully used for UI optimization of E-commerce platforms through identifying high-traffic bottlenecks and suitable product category groupings.

Keywords: *Graph theory, UI design, Retailrocket dataset, Betweenness centrality, Louvain method*

FORECAST-DRIVEN ATM CASH REPLENISHMENT OPTIMISATION USING DEMAND FORECASTING AND COST-BASED SCENARIO ANALYSIS

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Automated Teller Machine (ATM) cash management is a critical operational challenge in the banking sector due to fluctuating customer withdrawal demand and increasing cash handling costs. Traditional ATM replenishment methods, such as fixed schedules and threshold-based approaches, often fail to balance operational efficiency and service reliability. Excess cash in ATMs increases holding and security costs, while insufficient cash availability leads to stockouts, failed transactions and customer dissatisfaction. Therefore, this study aims to develop and evaluate a forecast-driven ATM cash replenishment optimisation framework that minimises operational costs while maintaining ATM service reliability. A simulated ATM operational dataset consisting of 50 ATMs and 18,250 ATM-day observations was developed to represent realistic banking operations. The dataset incorporated operational and temporal variables including ATM locations, ATM types, withdrawal behaviour, deposits, seasonal demand patterns, salary periods, weekends and holiday effects. Data validation techniques such as descriptive statistics, correlation analysis, boxplot analysis and operational logic validation were conducted to ensure dataset realism. ATM withdrawal demand forecasting was performed using four forecasting approaches. There are 7-day moving average, Regression, ARIMA (1,1,1) and Prophet. Forecasting performance was evaluated using Mean Absolute Error (MAE), Root Mean Squared Error (RMSE) and Mean Absolute Percentage Error (MAPE). Among the evaluated models, the regression forecasting model achieved the best forecasting performance with the lowest MAPE value of 19.66%, demonstrating its ability to capture operational demand patterns effectively. The forecasted withdrawals were integrated into a predictive replenishment optimisation framework. Five operational scenarios were evaluated using different target fill rates and buffer factors. The results showed that forecast-driven replenishment successfully eliminated ATM stockouts while improving operational efficiency. Optimal scenario, which used a 65% target fill rate and a 0.5 buffer factor, achieved the lowest total operational cost of 53.15 million LKR with zero stockout events. The findings demonstrate that integrating ATM demand forecasting with predictive replenishment optimisation can significantly improve ATM cash management performance by reducing operational costs and enhancing service reliability in commercial banking environments.

Keywords: *ATM cash management, Demand forecasting, Replenishment optimisation, Scenario analysis, Predictive analytics*

A HISTORICAL TREND ANALYSIS OF SPATIO-TEMPORAL SHIFTS IN SRI LANKA'S CLIMATIC ZONES AND A MACHINE LEARNING FRAMEWORK FOR FUTURE PROJECTION

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Global climate change affects rainfall patterns. Therefore, it is important to assess whether Sri Lanka's old climate zones are still accurate. This study was conducted to investigate spatio-temporal changes in Sri Lanka's climate zones boundaries over the past decades and predict the geographical distribution by 2050. Monthly data obtained from gauge stations from 1961 to 2020 were used for this analysis. To fill the missing data and estimate rainfall amount in areas without stations, the ordinary kriging interpolation method was used. Next, three methods were applied to identify boundary changes over the past decades among wet, dry, and intermediate zones. First, took a 30-year average (1991-2020) of interpolated rainfall data, then categorised them based on official rainfall thresholds and mapped their spatial distribution (rainfall-based climate zones). Second, the difference between the pixel count of the official climate zones and the rainfall-based climate zones was analysed annually (1991-2020) for each zone and plotted. Third, an unsupervised K-means clustering method was used to classify 30-year averaged interpolated rainfall values (1991-2020) into three zones to compare their overall spatial distribution with official zones. K-means was chosen because it uses simple distance math to group similar rainfall patterns into an unbiased map automatically. This makes the algorithm highly efficient, allowing us to process large spatial pixel grids quickly and accurately. Finally, use the Random Forest algorithm for future forecasting of climate zones because its strong capability in handling multi-class classification problems. Also, it uses an ensemble of decision trees to produce more stable predictions and reduce mathematical errors. All three methods show that the wet zone has shrunk. Pixel-based analysis showed that the dry zone has expanded throughout the time period. Most years, the intermediate zone also shows expansion compared to the official zone area. The rainfall-based climate zones show that the dry zone has expanded to the intermediate zone. Also, in some locations, the intermediate zone has expanded to the dry zone. The Random Forest model has 98.56% accuracy. The 2050 forecast from the Random Forest model shows the intermediate zone slightly expands into some dry zone areas, while the dry zone expands into some intermediate zone areas. The wet zone expands slightly into the intermediate zone, localised precisely between longitudes 80.5° E and 81.0° E at latitude 6.5° N. Overall, all these findings show that rainfall patterns of current official climate zones have changed and will continue to change by 2050.

Keywords: *Climate zones, Ordinary kriging, Random forest*

DEVELOPMENT OF AN INTERACTIVE STATISTICAL PROCESS CONTROL CHART APPLICATION FOR QUALITY MONITORING: A CASE STUDY OF AN APPAREL MANUFACTURING COMPANY IN SRI LANKA

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The apparel industry in Sri Lanka operates in a highly competitive global market in terms of pricing, quality, and timely delivery. Despite these challenges, Sri Lanka has established a strong reputation for manufacturing premium-quality garments that meet international quality standards. Therefore, quality has become a vital and integrated component of the production process. Although Statistical Process Control (SPC) tools and acceptance sampling methods are used in manufacturing to monitor product quality, the organisation still faces challenges in efficiently implementing, interpreting, and visualising these methods for real-time monitoring and decision-making due to the lack of interactive automated applications. This study aims to develop an interactive, real-time monitoring SPC web application using Shewhart Control Charts (p-charts), acceptance sampling techniques and process capability analysis. The developed application enables users to upload inspection datasets, from which p-charts are automatically generated. The system further allows users to input newly observed data and simultaneously updates the p-chart and determines whether the process is operating in control or out of control, thereby supporting real-time decision-making. Process Capability Analysis was incorporated to assess the ability of the process to satisfy required quality standards. Furthermore, the system integrates Operating Characteristic (OC) curve analysis within an acceptance sampling framework to estimate the producer's risk and the consumer's risk, sample size, and acceptance number, thereby supporting statistically informed acceptance and rejection decisions for production lots. The application successfully generated control charts for each production line using the End-line defect dataset collected during the period January 2025 to December 2025. The dataset was divided into Phase I and Phase II using an 80:20 training-testing split, where Phase I data were used to calculate upper and lower control limits for varying inspection quantities using the standardised method. The Phase II data were used to monitor ongoing process performance and identify out-of-control points. This approach follows standard SPC practice by separating the control limit estimation phase from the process monitoring phase, thereby enabling an unbiased assessment of future process performance. The developed application successfully identified out-of-control conditions, generated process capability measures, and supported acceptance sampling decisions, demonstrating its effectiveness for real-time quality monitoring and decision-making. The application can be effectively used for real-time quality monitoring, process stability evaluation, and acceptance sampling decision-making in manufacturing environments. The application is currently limited to p-chart-based quality monitoring using apparel manufacturing defect data and may require further enhancements to support additional SPC techniques and applications across other industries.

Keywords: *Apparel manufacturing, Shewhart control charts, Quality control, Acceptance sampling, Process capability analysis*

A SILVERSTONE-SPECIFIC FRAMEWORK FOR RANKING FORMULA ONE DRIVERS AND TEAMS AND PREDICTING VEHICLE SPEED USING FUNCTIONAL DATA ANALYSIS AND MIXED-EFFECTS MODELLING

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High frequency and high dimensional telemetry data, generated at around 2 GB per car per race weekend, remains a challenge for real-time team-strategy prediction and for constructing driver and team rankings that go beyond the championship-points system, which conflates driver contribution with car performance. This study develops a multi-staged statistical and machine-learning framework for instantaneous speed prediction and a circuit-specific ranking of drivers and teams using high-frequency telemetry from a single circuit. Telemetry data (10 Hz) for the 2021 to 2025 British Grand Prix (Silverstone) were obtained from the FastF1 Application Programming Interface (API). A total of 2967 clean laps from 26 drivers and 13 constructors (2.4 million rows) were retained after cleaning and partitioned into training and test sets. A Linear Mixed-Effects Model (LMM) incorporating lagged speed, throttle, brake status and tyre-compound interactions achieved a test-set Root Mean Squared Error (RMSE) of 0.892 m/s ($R^2 = 0.9981$), compared with 2.773 m/s for a Transformer neural network that did not use lagged speed as an input; because instantaneous speed is highly autocorrelated, this accuracy is driven substantially by the lagged-speed term, so the comparison is illustrative of architecture-information trade-offs rather than a like-for-like benchmark. Speed profiles were mapped onto a common 5 m distance grid and smoothed using penalised cubic B-splines. Functional Principal Component Analysis (fPCA) extracted four components, selected via the scree-plot elbow and physical interpretability, jointly explaining 88.55 percent of speed-profile variation ($PC1 = 72.73$ percent). These fPCA scores were each modelled via a linear mixed model with crossed random intercepts for driver, team and year. Best Linear Unbiased Predictors (BLUPs) for the driver effect, after adjusting for team and year, were combined into a composite score representing each driver's residual contribution to the speed profile beyond car and team performance, interpreted here as a Silverstone-specific skill proxy (driver intraclass correlation = 2.3 to 10.9 percent across components). The composite ranking placed Gasly, Hamilton and Alonso at the top among drivers, and Ferrari, McLaren and Red Bull as the top teams. Diagnostic checks supported model validity, with mild residual autocorrelation and the single-circuit, team-confounded design acknowledged as limitations. The fPCA-LMM framework provides a statistically principled, Silverstone-specific approach to disentangling driver- and team-level contributions to speed profiles, intended to complement rather than replace conventional race-result-based evaluation, and is extensible to other circuits.

Keywords: *Formula one, Functional data analysis, Mixed-effects models, Telemetry, Silverstone*

DATA-DRIVEN INVENTORY OPTIMISATION AND DEMAND FORECASTING TO PREVENT RAW MATERIAL STOCKOUTS: A CASE STUDY OF AN APPAREL ACCESSORIES MANUFACTURING COMPANY IN SRI LANKA

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Stockouts of raw materials in apparel manufacturing cause production disruptions, delayed order fulfilment, and financial losses. Conventional inventory practices relying on static reorder rules and manual forecasting fail to address the high variability and multi-material complexity of apparel supply chains. This study addresses raw material stockout prevention at ABC Company, a Sri Lankan apparel accessories manufacturer, by developing a data-driven framework for demand forecasting and inventory optimisation across seven raw material categories. The objective is to build an accurate demand forecasting model, determine scientifically grounded reorder points and safety stock levels per material type, and generate forward-looking replenishment forecasts using historical procurement data. Four years of transactional data comprising 642,821 cleaned records were analysed across issued, goods received note, and production requisition datasets. Demand distribution analysis confirmed a log-normal structure, and Multiple Linear Regression (MLR) was initially applied as a baseline model; however, residual diagnostics indicated violations of normality assumptions, motivating the use of Log-Normal Regression. Several statistical and machine learning approaches, including regression-based methods, Random Forest, and XGBoost, were evaluated to identify the most effective forecasting strategy. Reorder points and safety stock levels were computed per material at a 95% service level, and a three-way supply chain analysis compared requested, issued, and Goods Received Note (GRN) quantities to derive fulfilment rates and supply gap metrics. The Hybrid Random Forest model achieved the best forecasting performance with an average R^2 of 0.7930, outperforming all other evaluated models. Reorder point analysis revealed significant gaps between current and calculated thresholds, identifying stockout risk zones across material types. Supply chain analysis exposed fulfilment shortfalls and procurement consumption misalignments per material, providing actionable procurement recommendations. This study concludes that combining hybrid machine learning forecasting with inventory optimisation and procurement analytics delivers a data-driven solution to prevent raw material stockouts in apparel supply chains.

Keywords: *Demand forecasting, Inventory optimisation, Random forest, Supply chain management, Stockout prevention*

FACTORS ASSOCIATED WITH MOONLIGHTING (SECONDARY JOBHOLDING) AMONG EMPLOYED INDIVIDUALS IN SRI LANKA: EVIDENCE FROM THE LABOUR FORCE SURVEY 2024

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Secondary jobholding, commonly referred to as moonlighting, remains a significant yet empirically underexplored labour market phenomenon in Sri Lanka, where rising inflation and income insecurity during the country's most severe post-independence economic crisis have increased household financial pressure. This study investigates the socio-demographic and employment-related factors associated with secondary jobholding among employed individuals aged 15 and above, while examining five year trends in key labour force indicators over the period 2020–2024. Using microdata from the nationally representative Labour Force Survey 2024 and published Labour Force Survey Annual Reports for 2020–2024 by the Department of Census and Statistics, the study employs descriptive analysis, survey weighted binary logistic regression incorporating complex stratified sampling weights, and a macro-level trend analysis. Descriptive findings revealed that agricultural sector workers, part-time employees, low-income earners, self-employed individuals, and married workers showed the highest secondary jobholding propensities. Survey weighted logistic regression confirmed that, relative to their respective reference categories (services sector, full-time employment, unmarried status, male gender, government employment, low income, and rural residence), agricultural sector employment, part-time working hours, married status, and prime working age (age between 35 and 54, compared to the 25–34 age group) were significantly associated with higher moonlighting odds. By contrast, female gender, private sector employment, higher primary income, and estate sector residence were associated with substantially lower moonlighting odds. These findings are collectively consistent with the economic necessity, hours constraint, and household financial obligation hypotheses as explanatory frameworks for secondary jobholding in Sri Lanka. Trend analysis showed a participation paradox, with declining labour force participation and rising moonlighting at the 2023 crisis peak coinciding with peak underemployment, consistent with secondary jobholding acting as a household coping mechanism during economic shocks. Policymakers should prioritise minimum wage improvements, rural income support, and social protection targeting low income agricultural sector and self-employed workers, recognising moonlighting peaks as indicators of structural income insufficiency. The study is limited by the cross-sectional microdata design and small number of aggregate trend observations, both of which exclude causal inference. Future research should employ longitudinal panel data and household level expenditure variables to separate necessity driven from opportunity driven secondary employment in Sri Lanka.

Keywords: *Moonlighting, Secondary jobholding, Labour force survey, Survey weighted logistic regression, Sri Lanka*

EXTREME RAINFALL ASSESSMENT AND FORECAST VERIFICATION OVER SRI LANKA USING IMERG AND STATION BLENDED RAINFALL DATA

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Reliable rainfall information is important for Sri Lanka because rainfall changes strongly from place to place and heavy rainfall can cause floods, landslides, and other disaster impacts. Rain-gauge observations give direct ground rainfall, but they are not equally distributed over the country and they do not cover the ocean. IMERG (Integrated Multi-satellitE Retrievals for Global Precipitation Measurement mission) satellite rainfall gives wider rainfall coverage over land and ocean, but it can still have local errors during heavy rainfall. The main objective of this study was to use blended IMERG-station rainfall data and station-gauge observations for extreme rainfall assessment and rainfall forecast verification over Sri Lanka. The statistical methods used in this study included spatial interpolation, Cressman objective analysis, bias correction, correlation analysis, root mean square error (RMSE), mean absolute error (MAE), anomaly correlation coefficient (ACC), probability of detection (POD), false alarm ratio (FAR), and RMSE skill score. Three applications were considered: i) validation of rainfall during the Cyclone Ditwah extreme rainfall event, ii) comparison of ECMWF (European Centre for Medium-Range Weather Forecasts) and NCEP (National Centers for Environmental Prediction) real-time weekly rainfall forecasts, and iii) evaluation of ECMWF Sub-seasonal to Seasonal (S2S) reforecast rainfall skill. ECMWF and NCEP real-time forecasts are operational forecasts issued for upcoming weeks, while ECMWF S2S reforecasts are past forecasts produced for earlier dates and used to estimate forecast skill. For the Cyclone Ditwah event, blended IMERG-station rainfall agreed better with gauge observations than raw IMERG. The correlation increased from 0.64 to 0.95, while RMSE reduced from 58.44 mm to 21.43 mm. For the real-time weekly forecast comparison, blended IMERG-station rainfall was used as the reference over the common verification period and land domain. ECMWF generally showed better skill than NCEP, with ACC changing from 0.203 to 0.133 from week 1 to week 4, while NCEP changed from 0.198 to 0.111. For the ECMWF reforecast analysis, the ensemble mean gave more stable rainfall skill than the control forecast and individual members. Its ACC decreased from 0.41 at lead day 1 to 0.25 at lead day 28, and RMSE skill remained positive but small. The results show that blended IMERG-station rainfall data can be used as a useful statistical reference for studying extreme rainfall events and checking S2S rainfall forecast skill over Sri Lanka.

Keywords: *IMERG, S2S, ECMWF, NCEP, Forecast verification*

POLYMER AND MATERIAL SCIENCES

SYNERGISTIC CORROSION PROTECTION OF IRON USING EPOXY-BASED NANOCOMPOSITE CONSISTS OF GO AND SCHIFF BASE LIGAND-LOADED MESOPOROUS SILICA

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Corrosion of iron and steel structures poses significant economic, environmental, and safety challenges worldwide, particularly in saline-rich environments such as Sri Lanka's coastal regions. Conventional epoxy coatings possess inherent limitations, including micro-pores and permeability to corrosive species, which compromise long-term protection. This study focuses on the development and evaluation of a novel epoxy-based nanocomposite coating incorporating graphene oxide (GO) and Schiff base ligand-loaded mesoporous silica (SBL-MSN) to enhance the corrosion protection of iron substrates. GO and SBL-MSN were synthesised, followed by modification with APTS and then combined to form SBL-MSN-GO. The resulting nanocomposite was dispersed in an epoxy matrix and applied onto 99.99% pure iron substrates (SBL-MSN-GO/EP). To serve as controls, pure epoxy (EP), GO/EP, MSN/EP, SBL/EP, SBL-MSN/EP, and MSN-GO/EP coatings were prepared. The synthesised materials were characterised using FT-IR, UV-Vis, XRD, TGA, Raman spectroscopy, and SEM/EDX. FT-IR, XRD, and Raman spectroscopy confirmed successful oxidation of graphite to graphene oxide (GO), revealing O–H, C=O, and C–O functional groups, an increased interlayer spacing from 0.336 nm to 0.816 nm, and a D/G ratio of 1.27 indicating structural defects respectively. The synthesised Schiff base ligand showed a characteristic C=N stretch at 1610 cm^{-1} in FT-IR and $\pi \rightarrow \pi^*$ transitions at 202 nm and 253 nm in UV-Vis spectroscopy. FT-IR, TGA, and SEM/EDX analysis confirmed successful loading of the Schiff base ligand into mesoporous silica nanoparticles. Corrosion protection performance was evaluated through ferroxyl indicator tests, SEM imaging, and weight loss measurements in 3.5% NaCl solution over ten days. The ferroxyl indicator test revealed that the SBL-MSN-GO/EP coating exhibited minimal prussian blue coloration, indicating superior corrosion resistance. SEM images after 10 days of immersion in 3.5% NaCl showed that the SBL-MSN-GO/EP coating remained smooth and intact, while bare iron displayed severe corrosion. The SBL-MSN-GO/EP coating exhibited superior corrosion resistance compared to pure epoxy and other control coatings, achieving an inhibition efficiency of 90.04% with a corrosion rate of only $0.0264\text{ mg cm}^{-2}\text{ h}^{-1}$. The enhanced performance is attributed to the synergistic combination of GO's barrier properties, MSN's role as a nanocontainer and dispersing agent, and the active corrosion inhibition provided by the Schiff base ligand through chemisorption onto the iron surface via electron donation from O, N, and Cl atoms forming a hydrophobic film. In conclusion, within the ten-day evaluation period, the SBL-MSN-GO/EP nanocomposite coating presents a promising strategy for corrosion protection in aggressive saline environments.

Keywords: *Corrosion protection, Graphene oxide, Mesoporous silica, Schiff base ligand, Nanocomposite coating*

ROOT-CAUSE IDENTIFICATION AND MITIGATION OF WHITE FLAKES DEFECT IN POLYISOPRENE GLOVES

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Synthetic *cis*-polyisoprene (PI) latex is widely used in high-performance healthcare gloves but is inherently fragile and highly susceptible to colloidal destabilisation due to its lack of native stabilising proteins and lipids. A persistent manufacturing issue is the appearance of micron-scale white flakes on the cured film, causing severe cosmetic defects and material waste. This study investigates the root causes of these defects and develops a robust mitigation strategy. Using sequential compounding trials, the defect was traced to the addition of the primary antioxidant dispersion combined with titanium dioxide TiO₂. Due to a strictly limited surfactant budget, introducing these high-surface-area solid particles triggers competitive surfactant adsorption from surrounding PI rubber particles, inducing localised complex coacervation and microcluster aggregation. To resolve this, a dual-action stabilisation strategy was implemented: increasing the dispersing agent during milling to reduce the antioxidant hydrodynamic particle size from 1144.6 nm to 785.0 nm, and boosting the anionic surfactant levels in the bulk latex compound. Production-scale validation confirmed that this approach successfully suppressed the white-flake defect. Although the enhanced surfactant system initially decreased the unaged tensile strength from 26.33 MPa (control) to 22.30 MPa (trial) due to temporary interfacial barriers to polymer chain interdiffusion, accelerated aging tests demonstrated a full mechanical recovery to 27.92 MPa, well exceeding industrial regulatory standards.

Keywords: *Synthetic polyisoprene, Colloidal stability, Surfactant demand, Tensile strength, Complex coacervation.*

EFFECT OF BLENDING CONCENTRATED NATURAL RUBBER LATICES FROM DIFFERENT ORIGINS ON COLLOIDAL STABILITY AND FILM PROPERTIES

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Sri Lanka increasingly depends on blending imported and local centrifuged latex owing to a significant decline in domestic rubber production. Among centrifuged grades, the low ammonia-tetramethylthiuram disulphide/zinc oxide (LATZ) preserved type is the most widely used. However, variations in non-rubber constituents and ionic composition among sources can affect latex stability and processing performance. This study investigated the effects of blending LATZ latices from different geographical origins on physicochemical properties, colloidal stability, structural characteristics, and latex film performance. Two imported latex samples from the Southeast Asian region (A and B) and one locally sourced latex sample (C) were blended at an industrially practised ratio of 1:1:1.5 to produce a blended sample (D). Physicochemical parameters, stability indicators such as mechanical stability time (MST), chemical stability time (CST), higher fatty acid (HFA) number, zeta potential, together with particle size distribution and latex film mechanical properties and crosslink density were evaluated. Blending effects were determined using one-sample t-tests against weighted predicted averages ($\alpha = 0.05$). The physicochemical parameters of Sample D, including total solid content, dry rubber content, non-rubber content, alkalinity, viscosity, volatile fatty acid number, and total phosphate content, closely followed weighted predictions, confirming additive mixing behaviour. All samples complied with ISO 2004:1997 requirements except Sample A, which exhibited lower mechanical stability associated with elevated phosphate content. Although HFA number alone was insufficient to explain MST variation in this study. The blended latex exhibited an intermediate particle size distribution. Critically, the blend achieved synergistically enhanced MST (796 ± 1.15 s) and CST (394 ± 6.03 s), significantly exceeding predictions (705 s and 338 s; $p = 0.00005$ and $p = 0.004$, respectively), supported by restored electrostatic stability through redistribution of surface-active species from more stable latex fractions onto the less stable rubber particles. The blended film exhibited improved tensile strength, modulus, and crosslink density compared with the control film prepared solely from the local latex sample (Sample C). This improvement is attributed to the contribution of Sample B, which contained higher proportion of small rubber particles that promote sulfur vulcanisation. The findings demonstrate that blending LATZ latices from different origins at the industrially relevant ratio can improve colloidal stability, enabling substandard latex sources to meet ISO specifications whilst simultaneously enhancing mechanical properties.

Keywords: *Centrifuged natural rubber latex, Low ammonia, Latex blending, Colloidal stability, Particle size*

EFFECT OF ENZYMATIC DEPROTEINISATION ON THE RAW RUBBER PROPERTIES OF SKIM NATURAL RUBBER

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Skim latex, a byproduct of natural rubber centrifugation, contains a high concentration of proteins that limit its utilisation due to allergenic potential and reduced oxidative stability. Although enzymatic deproteinisation has been widely studied for natural rubber latex, limited attention has been given to the upgrading of skim latex, a low-value industrial byproduct, while preserving its raw rubber properties. This study investigated the effect of Savinase-assisted enzymatic deproteinisation on the raw rubber properties of skim natural rubber. Savinase was added to skim latex containing 3.17% dry rubber at 1.7-2.3 mL/L and incubated for 24, 48 and 72 hours. The treated samples were coagulated and analysed for nitrogen content, initial plasticity (Po), plasticity retention index (PRI), Mooney viscosity, ash content and volatile matter by ISO standard methods. The optimal treatment condition was 1.8 mL/L Savinase and incubation for 72 hours, which reduced the nitrogen content from 2.65% to 0.34%, followed by leaching to about 0.24%. The initial plasticity was not changed because the polyisoprene backbone was survived during the deproteinisation process and the PRI increased from 12.5 to more than 34, indicating a better resistance to thermal oxidative degradation. Mooney viscosity decreased slightly, which means it has improved processability. It was observed that the ash content has increased post treatment which can be attributed to the inorganic materials that were not removed from the sample during the treatment and needs to be optimised. The results indicated that the Savinase treatment method can be used to reduce the protein content of skim latex and maintain the important properties of raw rubber. The findings of this study indicate that skim latex may be used as a reduced allergen raw material in applications where a reduced allergen potential is desired, and further biological safety testing is required to determine its suitability for direct skin contact applications.

Keywords: Savinase, Enzymatic deproteinisation, Skim latex, Nitrogen content, Raw rubber properties.

Acknowledgement: This research was funded by the Rubber Research Institute of Sri Lanka (RRI).

DEVELOPMENT OF CHITOSAN BASED FILMS INTEGRATED WITH *Sesbania grandiflora* LEAF EXTRACT FOR ENHANCED ANTIOXIDANT AND ANTIMICROBIAL PROPERTIES

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The global escalation of environmental degradation caused by traditional petroleum based food packaging systems has necessitated a radical shift toward sustainable, biodegradable and functional alternatives. Conventional plastics, while providing effective mechanical and moisture barriers are intrinsically passive and lack the bioactive capacity to mitigate the biochemical and microbial processes that drive the spoilage of perishable commodities. This research focuses on the development and characterisation of a novel active packaging film synthesised through the integration of *Sesbania grandiflora* leaf extract into a chitosan matrix. The overarching objective was to harness the synergistic potential of chitosan's film forming capabilities and the potent antioxidant and antimicrobial secondary metabolites found within *S. grandiflora*. The leaves were harvested, dried and subjected to an extraction process using 95% ethanol. Based on existing literature, this extraction method typically isolates a rich profile of secondary metabolites in *S. grandiflora*, including phenolics, alkaloids and specific flavonoids such as quercetin and kaempferol. The fabrication of the composite films involved dissolving 2.5 g of medium molecular weight chitosan in a 1% acetic acid solution, followed by the incorporation of glycerol as a plasticiser and 1% w/v of the plant extract. The resulting films were cast and stabilised at room temperature. Characterisation was conducted via Fourier Transform Infrared (FTIR) spectroscopy and the agar well diffusion method to evaluate molecular interactions and functional performance. FTIR analysis definitively confirmed the successful integration of bioactive constituents, evidenced by significant shifts in the amide I and amide II peaks, signifying the establishment of robust intermolecular hydrogen bonding between the polyphenolic hydroxyl groups and the chitosan backbone. The composite films demonstrated antimicrobial efficacy, producing significant zones of inhibition against both *Staphylococcus aureus* and *Escherichia coli*, thereby validating their capacity to control foodborne pathogens. These findings confirm that *S. grandiflora* extract acts as a multifunctional bioactive agent, enabling a transition from passive barriers to active systems that actively extend shelf life. This study recommends further optimisation of thermal and mechanical properties to facilitate industrial scale adoption within the sustainable packaging sector.

Keywords: Chitosan, *Sesbania grandiflora*, Antimicrobial, Sustainable packaging, Biodegradable film

EVALUATION OF TIME – TEMPERATURE HISTORY OF POLYURETHANE ADHESIVE FILMS

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Polyurethane adhesives have been successfully used for advanced composites manufacturing due to their unique mechanical properties and long-term stability. However, the curing reactions which continue to take place during storage and handling have a prominent impact on their final performance. Yarn-reinforced polyurethane adhesive films are commonly employed for composite fabrication due to their dimensional stability and mechanical strength, yet the time or temperature-dependent nature of the property loss limits workability and bond strength unless crosslinking reactions are tightly controlled. These materials are industrially relevant. However, no systematic data exists evaluating the influence of different storage times and temperatures on the chemical kinetics governing the formation of yarn-reinforced polyurethane adhesive films suitable for high-tech applications that demand defined mechanical performance. This study aims to quantify the impact of varied time–temperature histories on the curing progression of polyurethane adhesive tapes and to establish reliable expiration margins for their use in advanced composite manufacturing processes. Tape samples were stored at seven different controlled temperatures (-16°C, 7.5°C, 17.95°C, 25.27°C, 29.75°C, 30.65°C, and 34.25°C) to analyse peel bond strength and chemical cure state using FTIR-based industry specific NCO ratio analysis. Selected tape samples were aged for specified durations at defined temperatures and then tested for mechanical performance using 180° peel bond strength testing and quantitatively measured the loss of isocyanate (NCO) groups using FTIR. Experiments found that ambient or above-ambient temperature conditions degraded adhesive properties below pass limit in as little as 4-9 days, while frozen storage preserved adhesive performance for over 112 days. FTIR data confirmed rapid NCO consumption at elevated temperatures and revealed a threshold in the NCO ratio (~0.13-0.2), below which mechanical failure occurs. These findings can support the development of storage guidelines, FTIR-based quality screening, and provide scientific justification for optimal shelf-life protocols for polyurethane adhesive films used in composite manufacturing.

Keywords: Polyurethane adhesive films, Time–temperature history, Peel bond strength, Cure progression, Shelf-life prediction

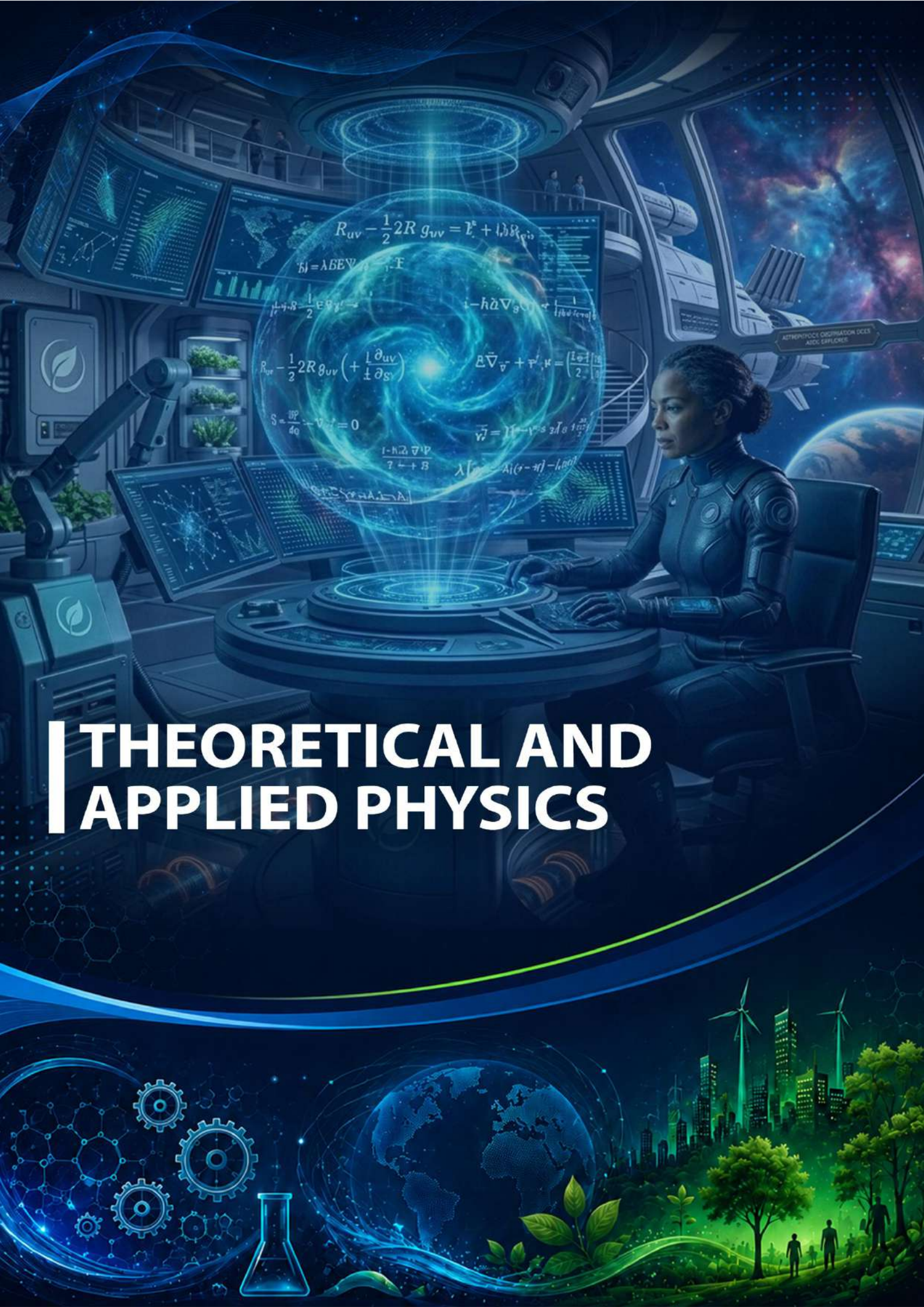
DEVELOPMENT OF A BIOBASED MULTILAYER FILM FOR FOOD PACKAGING APPLICATIONS

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The increasing environmental burden associated with petroleum-based packaging materials has accelerated the development of sustainable alternatives for food packaging. In this study, a multifunctional three-layer biobased composite film was developed using chitosan as the primary polymer matrix reinforced with cellulose nanocrystals (CNCs) extracted from cotton wool via sulfuric acid hydrolysis. The multilayer structure was designed to integrate passive, active, and intelligent packaging functionalities within a single system. The outer barrier layer consisted of chitosan, CNC and glycerol to provide structural integrity and enhanced barrier performance. The middle active layer incorporated a neem oil nanoemulsion to impart antimicrobial functionality, while the inner intelligent layer contained red cabbage anthocyanin extract to enable pH-responsive spoilage indication. Individual layers were fabricated through sequential solvent casting with controlled 24 h drying intervals to ensure interfacial adhesion and structural stability. Mechanical characterisation revealed a significant improvement in tensile strength from 0.10-0.35 MPa for pure chitosan reference films to 9.41-17.66 MPa for the multilayer composite films, indicating effective reinforcement by CNC incorporation and multilayer architecture. Thermogravimetric analysis demonstrated thermal stability up to approximately 230°C, with major degradation occurring between 230-450°C and a residual char yield of approximately 30%, confirming improved thermal resistance. Differential scanning calorimetry indicated enhanced chain mobility due to glycerol plasticisation. The developed multilayer film demonstrates strong potential as a sustainable alternative to conventional food packaging by combining mechanical durability, antimicrobial protection, and intelligent freshness monitoring within a single biodegradable material system.

Keywords: *Chitosan, Multilayer film, Intelligent food packaging, Cellulose nanocrystals, Antimicrobial packaging*



THEORETICAL AND APPLIED PHYSICS

DETERMINATION OF SPIRAL ARM PITCH ANGLES IN SPIRAL GALAXIES USING PYTHON-BASED IMAGE ANALYSIS

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This study aimed to determine and compare the pitch angles of selected spiral galaxies using Python-based image analysis techniques. The pitch angle is one of the basic parameters used to describe the tightness or looseness of spiral arms around the galactic centre and is important in the study of galactic morphology and dynamics. FITS images of the selected galaxies were obtained from the NASA/IPAC Extragalactic Database (NED), while the inclination and position angles required for image deprojection were obtained from HyperLEDA. The images were processed using Python scripts to perform deprojection to a face-on orientation, determine the galactic centre, crop the galaxy region and remove unwanted foreground stars. The processed images were then transformed into logarithmic polar coordinates and spiral arm pitch angles were determined using two-dimensional Fast Fourier Transform (2DFFT) analysis. In this study, pitch angles were measured for ten different spiral galaxies and compared with published values. Good agreement was obtained for several galaxies including for M51, NGC 578, NGC 1042, NGC 3513, NGC 5054 and NGC 5247. For M51 galaxy, the archival KPNO 0.9m image produced a pitch angle of $14.39 \pm 0.34^\circ$, while the ground-based image obtained using the GOTO 45cm telescope at the Arthur C Clarke Institute for Modern Technologies produced a value of $-14.93 \pm 1.19^\circ$, where the sign indicates the winding direction of the spiral arms in the galaxy. Larger deviations from published values were observed for galaxies such as NGC 289, NGC 4030 and NGC 7793. These differences are likely due to faint or disturbed spiral structures, low signal-to-noise ratios, foreground star contamination, uneven background illumination and limited image resolution. These results demonstrate that Python-based 2DFFT analysis provides a practical and effective method for estimating spiral arm pitch angles. The accuracy and reliability of the measurements are strongly dependent on the quality of the imaging data, precise deprojection parameters and the careful selection of the radial fitting range.

Keywords: *Spiral, Pitch angle, Morphology, FITS, 2DFFT, Deprojection*

ANALYSIS OF SEQUENTIAL EXTREME PRECIPITATION HEATWAVE COMPOUND EVENTS (SEPHCE) ACROSS COLOMBO, RATNAPURA AND ANURADHAPURA, SRI LANKA (2014 - 2024)

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Climate variability has increased the occurrence of compound extreme events worldwide, particularly sequential events such as heatwaves followed by extreme precipitation. In Sri Lanka, limited research has addressed sequential compound events and spatial variability across different climatic zones. This study analyses Sequential Extreme Precipitation Heatwave Compound Events (SEPHCE) across three stations: Colombo (urban wet zone), Ratnapura (wet zone with high landslide susceptibility), and Anuradhapura (dry zone). Daily rainfall and daily maximum temperature data from 2004 to 2024 were obtained from the Department of Meteorology, Sri Lanka. Extreme heat days were identified using the TX90p index, where the percentage of days on which the daily maximum temperature exceeds the 90th percentile threshold. Heatwave was defined as three or more consecutive days above the percentile for maximum temperature which was calculated for each calendar day based on the base period (2004-2013). Extreme precipitation days were identified using the Simple Daily Intensity Index (SDII), which provides a single threshold value representing the average precipitation intensity on wet days ($\geq 1\text{mm}$) over the entire study period (2004-2024). Rainstorm events were identified as one or more consecutive days of extreme precipitation. Previous research commonly adopted a fixed temporal window to link component hazard events within a compound event, with lag periods of 1, 3, 5, and 7 days. In this study, SEPHCEs were identified within the reference period from 2014 to 2024 with the same lag windows. The results reveal clear spatial variability in SEPHCEs. A total of 105 SEPHCEs, most events (48) were occurred within 1 day lag window. Ratnapura recoded the highest total number of events and Anuradhapura recoded the lowest across these three stations. These variations are associated with differences in atmospheric humidity, moisture availability, urban heat effects, and climatic zone characteristics. The year 2024 exhibited the highest annual SEPHCE frequency at all three stations, surpassing all preceding years within the 2014-2024 reference period. However, Mann-Kendall trend test results indicate no statistically significant short-term trend in annual event frequency. Average frequency analysis further reveals that short time events are more frequent and consistent across stations. These findings emphasise the need to consider sequential compound events in climate risk assessment and adaptation planning. Expanding spatial coverage and uncovering the underlying atmospheric drivers are critical next steps. These efforts will be carried out to refine predictive models and develop more robust risk mitigation strategies.

Keywords: *Compound extreme events, TX90p, SDII, Heatwave, Precipitation*

DETERMINATION OF THE METALLICITY OF ALDEBARAN USING OPTICAL SPECTROSCOPY

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Stellar metallicity, expressed as $[Fe/H]$, represents the abundance of iron in a star relative to the Sun. It is an important parameter because it gives information about the chemical composition and evolutionary history of a star. The novelty of this study is the first local observational metallicity analysis of Aldebaran in Sri Lanka using raw spectra. The objective of the study is to estimate the metallicity of Aldebaran, a bright K-type giant star, using optical spectroscopy and synthetic spectral comparison. The spectra of Aldebaran and the standard star Elnath were obtained using the “GOTO 45 cm telescope” at the Arthur C Clarke Institute. The observed spectral range was from 4750 Å to 7000 Å. Fe/Ne comparison lamp spectra were used for wavelength calibration. The raw CCD (Charge Coupled Devices) spectroscopic FITS (Flexible Image Transport System) images were reduced using IRAF (Image Reduction and Analysis Facility). The reduction included bias subtraction, dark correction, spectral extraction, wavelength calibration, flux calibration and continuum normalisation. The final normalised Aldebaran spectra was used for spectral analysis in “XSpectrum analysis9”. “ATLAS9” model atmospheres and the “SPECTRUM” synthesis code were used to generate synthetic spectra. Synthetic spectra were calculated for different metallicity values from +0.3 to −0.3 and compared with the observed spectra. The synthetic spectra were smoothed using Gaussian profile convolution to match the moderate resolution of the observed spectra. The final comparison focused on the absorption regions consisting of two usable Fe I absorption lines near 5528 Å and 6065 Å. Equivalent-width comparisons were refined by testing several closely spaced wavelength intervals around each selected absorption line in the $[Fe/H] = -0.3$ synthetic spectrum. The smoother synthetic profiles were used as references to define the line wings, and the interval yielding the smallest observed-synthetic equivalent-width difference was applied to the other metallicity models. The best agreement was obtained at $[Fe/H] \approx -0.3$. For the Fe I 5528 Å absorption line, the observed equivalent width was 364.2 mÅ and the synthetic value was 365.8 mÅ. For the Fe I 6065 Å line, the observed equivalent width was 407.2 mÅ and the synthetic value was 410.0 mÅ. The mean observed-synthetic equivalent-width gap was 2.96 ± 1.43 mÅ for the 5528 Å and 7.58 ± 3.05 mÅ for the 6065 Å. These results support that Aldebaran has a slightly sub-solar metallicity. However, the result should be treated as an approximate estimate because the spectra were affected by moderate spectral resolution, line blending, continuum placement uncertainty and low signal-to noise ratio.

Keywords: Aldebaran, Equivalent width, Metallicity, Optical spectroscopy, Synthetic spectra

A STATISTICAL INVESTIGATION OF SUNSPOT DYNAMICS AND PANDEMIC OCCURRENCES (1800-2025)

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The idea that solar activity affects the occurrence of pandemics has been a matter of discussion in scientific literature, but thorough empirical analysis with all historical data is still scarce. The objective of this study was to determine if there is a statistically significant correlation between the yearly mean sunspot number and pandemic occurrence in a time span of 225 years (1800 to 2025). The aim was to see if there was a significant difference in the level of solar activity during pandemic years compared to that of non-pandemic years and to create a machine learning model that could predict future sunspot activity. Historical solar observation data were then used to create yearly mean sunspot data were sourced from the Royal Observatory of Belgium's SILSO database and correlated with the pandemic years classified according to what is defined as a pandemic by the World Health Organisation (WHO) in six classes of disease, cholera, influenza, plague, meningitis, viral outbreaks, and typhus. To quantify the statistical association between solar activity and the timing of the pandemic, an independent-samples t-test, Cohen's d effect size calculation, and Pearson's correlation analysis were used. The data did not show a significant difference between the pandemic years (mean = 78.94) and the non-pandemic years (mean = 85.71) with $t = -0.62$, $p = 0.537$, and only an effect size of 0.109% of variance accounted for by solar activity. The range of pathogen-specific Pearson correlations was from $r = -0.113$ to $+0.122$, all values were close to zero for each disease category. Visual analysis verified that the pandemic years were equally distributed in all the phases of the solar cycle. The results put solid statistics to the question of independence of these two phenomena solar activity and pandemic occurrence. Timing the pandemic is determined by epidemiology, not by solar cycles, as there are epidemiology-determined factors such as novelty of the pathogen, population immunity, sanitation, and social conditions. Further work involves using a finer temporal resolution classification for pandemics and investigating the incorporation of machine learning in epidemiological modelling frameworks.

Keywords: *Sunspot numbers, Pandemic occurrence, Solar activity, Pearson's correlation, Epidemiological statistics*



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