6TH CINEC International Research Symposium Proceedings

Sustainability and Beyond – Unlocking the Power of Research

CIRS2025

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@ CINEC Campus, Malabe, Sri Lanka.

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6th CINEC INTERNATIONAL RESEARCH SYMPOSIUM

CIRS2025

Sustainability and Beyond - Unlocking the Power of Research

1st & 2nd October 2025

CINEC Campus, Malabe

Sri Lanka

Proceedings

Faculty of Engineering and Technology

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Preface

NEXORA | An Industry – Academia Nexus

Day 1: Inauguration of CIRS2025

NEXORA, the flagship industry–academic engagement platform of the 6th CINEC International Research Symposium (CIRS2025), serves as a pioneering forum that unites academia, industry leaders, policymakers, and innovators. Conceived as a full-day event held on 1st October 2025 at the Hilton Colombo Residences, NEXORA is designed to foster dialogue, collaboration, and the co-creation of knowledge between two key drivers of national development: universities and industries. It represents a unique space where forward-thinking research converges with practical challenges, enabling solutions that are both sustainable and impactful. The programme is structured around four thematic areas of contemporary importance:

1. *Sustainable Development*: Driving National Development through Sustainable Innovations
2. *Digital Transformation*: Empowering a Smarter Nation through Digital Transformations
3. *Medical Innovation*: Fostering Medical Innovations for National Wellbeing
4. *Maritime & Hospitality*: Driving Impact in Logistics, Maritime, and Hospitality Sectors

A signature feature is the *TriNOVA 3-Minute Innovation Competition*, where emerging researchers and practitioners communicate high-value ideas with clarity and impact. TriNOVA strengthens presentation and translational skills while spotlighting solutions with near-term applicability for industry and society. NEXORA is honoured by the participation of distinguished dignitaries, Distingushed Chief Guest, *Dr. Hans Wijesuriya* and Guests of Honour, *Desamanya Mahesh Amalean* and *Professor Ranjith Dissanayake*. Their leadership across enterprise and academia underscores NEXORA's mission to catalyse partnerships, inform policy, and accelerate innovation NEXORA extends the reach of scholarship beyond the laboratory and classroom. It helps researchers align agendas with industry needs, secure collaborators, gain feedback on applicability, and access pathways for technology transfer and talent development. Students benefit from exposure to real-world constraints, entrepreneurial mindsets, and professional networks. In turn, industries tap into cutting-edge research, facilities, and expertise—co-designing solutions that advance competitiveness and sustainability. As a flagship initiative of CIRS 2025, NEXORA embodies the symposium theme, *"Sustainability and Beyond – Unlocking the Power of Research."* By connecting knowledge creation with market and societal needs, NEXORA strengthens Sri Lanka's innovation ecosystem and positions research as a practical driver of national development.

Technical Sessions of CIRS2025

Day 2: Technical Sessions and Scholarly Dissemination

Day 2 of CIRS2025 is dedicated to rigorous scholarly dissemination across the symposium's academic tracks. The technical sessions bring together researchers, practitioners, and students to present peer-reviewed work, exchange perspectives, and explore collaborations that advance knowledge and practice. Sessions comprise oral presentations with moderated Q&A and interactive poster discussions that encourage one-to-one engagement and constructive feedback. We are honoured to feature *Prof. Dilushan Jayasundara*, Professor of Materials Science, Department of Physics, University of Colombo, as the Day 2 Keynote Speaker. His address sets the tone for the day by highlighting frontier research directions and pathways for societal impact. All abstracts are submitted through the symposium platform and undergo a two-stage evaluation:

1. *Editorial screening* for scope alignment, ethics and compliance, clarity of writing, and adherence to formatting guidelines.
2. *Double-blind peer review* by two (minimum) to three (maximum) expert reviewers drawn from academia and industry, with an area chair/track chair decision in case of divergent recommendations.

To preserve fairness and quality, reviewers follow calibrated rubrics and declare conflicts of interest. Where appropriate, authors may be invited to revise and resubmit within a short window to address essential comments before final acceptance. Submissions are evaluated against the originality and significance of the research question and contribution, methodological rigour including study design, analysis, and reproducibility, technical depth and correctness appropriate to the track. Through this process, Day 2 reaffirms CIRS2025's commitment to academic excellence and societal relevance. By championing robust peer review, transparent selection, and high-quality scholarly exchange, the technical sessions strengthen Sri Lanka's research ecosystem and contribute to sustainable solutions for the future. Beyond the formal sessions, Day 2 also fosters meaningful networking opportunities among delegates, encouraging cross-disciplinary dialogue and future collaborations. Informal discussions, poster interactions, and shared learning moments create an inclusive environment where emerging researchers can connect with senior academics and industry leaders. These engagements ensure that the symposium not only disseminates knowledge but also builds lasting partnerships that contribute to innovation and national development.

Symposium Tracks

Engineering & Technology

Engineering the Future: Sustainable Innovations for a Resilient World

Focusing on innovative engineering solutions, this track highlights sustainable technologies that contribute to building resilient infrastructure, renewable energy systems, and future- ready technological applications for a greener world.

Computing & IT

Empowering Community Sustainability through Data-Driven Insights in ICT Research

This track explores how advancements in Information and Communication Technology (ICT) can empower sustainability. Topics include data-driven insights, artificial intelligence, machine learning, and smart systems aimed at addressing environmental, social, and economic challenges within communities.

Health Sciences

Sustainable Health Sciences: Driving Green Innovations and Transformative Education

This track emphasizes sustainability in healthcare, covering innovations in green medical technologies, sustainable healthcare practices, and transformative approaches to health education that support long-term well-being and environmental responsibility.

Management & Social Sciences

Innovative Strategies for Sustainable Business and Economic Growth

This track examines strategies for sustainable business, governance, and social development. It emphasizes innovative models, policies, and practices that drive economic growth while ensuring social equity and environmental stewardship.

Humanities & Education

Innovative Pedagogies and Cultural Perspectives: Advancing Sustainable Education

Exploring the human dimension of sustainability, this track focuses on cultural perspectives, innovative pedagogies, and the role of education in shaping sustainable mindsets and practices for future generations.

Maritime Sciences

Sustainable Seas: Innovations in Navigation for Efficiency and Safety

Dedicated to sustainable navigation, this track highlights innovations in maritime operations that improve efficiency, safety, and environmental responsibility within global shipping and ocean resource management.

Marine Engineering

Sustainable Seas: Innovations in Maritime Engineering for Efficiency and Safety

This track focuses on technological advancements in marine engineering, addressing sustainability in ship design, propulsion systems, maintenance, and marine operations to promote safer and greener seas.

Science

Scientific Innovations for a Sustainable and Resilient Future

Highlighting cross-cutting scientific contributions, this track showcases fundamental and applied research aimed at advancing sustainable practices, environmental resilience, and technological innovations for future generations.

Messages & Remarks

The Message from the President of CINEC Campus

Capt. Ajith Peiris

It is with happiness and pride that I convey my message to the 6th CINEC International Research Symposium. As President of CINEC, one of my foremost aspirations has been to strengthen and uplift the research culture within our institution. The symposium, now in its sixth consecutive year, stands as a testament to this vision and reflects the commitment of our academic community to advance knowledge, innovation, and collaboration. The theme of this year's symposium, "Sustainability and Beyond: Unlocking the Power of Research," could not be more relevant. It highlights our collective responsibility to harness the transformative capacity of research in addressing pressing global challenges, while envisioning a future that is inclusive, resilient, and sustainable. Through such platforms, CINEC reaffirms its role as a leading higher education institution that not only imparts knowledge, but also drives inquiry, innovation, and impact. A significant milestone this year is the introduction of NEXORA, an industry–academia forum integrated into the symposium for the first time. NEXORA provides a new dimension to CIRS, creating a vital nexus where academic research and industry practice converge to deliver solutions of national and global relevance. This initiative underscores the importance of collaboration in shaping outcomes that extend far beyond the walls of academia. I extend my great appreciation to the Faculty of Engineering & Technology, who have undertaken the responsibility of organising this year's symposium. Their dedication, together with the tireless efforts of the organising committees, faculty, students, sponsors, industry partners, and volunteers, has ensured that CIRS2025 is a resounding success. On behalf of CINEC, I commend all participants for their contributions and encourage you to continue pushing the boundaries of knowledge and innovation. CINEC will continue to stand as a beacon of research and innovation in Sri Lanka and the region, committed.

Message from the Consultant – Academic Affairs and Research

Dr. Ajith Madurapperuma

I am delighted to extend my greetings on the occasion of the CINEC Campus Annual Research Symposium 2025. This symposium has become a premier event, providing a distinguished forum for our faculty, students, and external scholars to present their research, exchange ideas, and forge lasting intellectual partnerships. We convene at a time of unprecedented and rapid transformation in the global technological landscape. Advancements in Artificial Intelligence, Big Data analytics, the Internet of Things, biomedical technologies, and immersive platforms like Virtual and Augmented Reality are not only reshaping industries but are also fundamentally altering the way we live, work, communicate, and learn. Consequently, these developments are redefining research priorities across all disciplines. In this dynamic environment, the role of research is more critical than ever. It is imperative that we explore how these powerful technologies can be harnessed to improve the human condition in both ethical and sustainable ways. The robust participation in this symposium, including a significant number of submissions from international researchers, underscores CINEC's strong commitment to fostering cutting-edge, socially relevant research and its growing role as a vital platform for the dissemination of findings and dynamic scholarly discourse. May this year's symposium act as a powerful catalyst for new knowledge, innovative solutions, and continued academic excellence. I encourage all participants to extend their discussions beyond these two days, building collaborative partnerships that will leverage these emerging technologies for the profound benefit of society.

The Message from the Chief Guest | NEXORA
Chief Advisor to the President on Digital Economy

Dr. Hans Wijayasuriya

It is with great pleasure that I extend my heartfelt appreciation to the organisers of NEXORA: Industry–Academia Nexus 2025. This timely initiative represents a critical juncture in Sri Lanka's journey towards building a sustainable, inclusive, and digitally empowered nation. As the world undergoes rapid transformation driven by technological advancement, the convergence of industry and academia has never been more important. Academia provides the bedrock of research, knowledge creation, and innovation, while industry serves as the catalyst that converts ideas into practical, scalable, and impactful solutions. When these two forces collaborate meaningfully, they not only advance their respective domains but also create pathways for national progress. Sri Lanka today stands at the threshold of significant opportunity. The Government's vision for a digitally inclusive economy is centred on harnessing technology to enhance competitiveness, empower citizens, and strengthen the fabric of our society. To realise this vision, we must nurture a culture where industry insights and academic research intersect, where talent and technology are harmonised, and where sustainability is embedded into every solution we design. NEXORA embodies this spirit of collaboration. It provides a platform for dialogue, innovation, and partnership, enabling stakeholders to reimagine industries, redefine education, and co-create solutions to pressing national and global challenges. In doing so, it not only supports the development of a robust digital economy but also contributes to building a knowledge-driven society. I commend CINEC Campus for spearheading this important initiative and for fostering a space where ideas can flourish into impactful outcomes. Let us embrace this opportunity to strengthen the bonds between academia and industry, and in doing so, ensure that Sri Lanka is equipped to thrive in an era defined by change, resilience, and innovation.

Message from the Guest of Honour and Keynote Speaker | NEXORA
Co - Founder / Chairman, MAS Holdings (Pvt) Ltd.

Desamanya Mahesh Amalean PhD h.c

It is a privilege to join the 6th CINEC International Research Symposium and to be part of NEXORA — the Industry-Academia collaboration platform. Its vision of "Sustainability and Beyond – Unlocking the Power of Research" is both timely and vital for the Academia, the industries and for the country. My personal and professional journey has always been shaped by a willingness to step out of comfort zones and to embrace the power of research, innovation, and partnerships. We have seen how meaningful collaboration between universities and industry can solve real problems, unlock opportunities, and build ecosystems where knowledge moves from lab to market with tangible impact. For Sri Lanka, advancing global competitiveness will depend on how boldly we foster such connections between academia and industry. By daring to innovate together, we can transform not only companies and sectors, but our nation's place in the world.

Message from the Guest of Honour and Keynote Speaker | NEXORA Chairman, gapHQ / Professor Emeritus

Prof. Ranjith Dissanayake

I am deeply honored to join NEXORA: Industry–Academia Nexus 2025 as Guest of Honour and Keynote Speaker. This flagship initiative of the CINEC International Research Symposium (CIRS2025) is both timely and impactful, serving as a vital platform for bridging the worlds of academia and industry. Guided by the overarching theme, "Sustainability and Beyond: Unlocking the Power of Research," NEXORA underscores the urgency of closing the gap between academic innovation and industrial practice. By convening corporate leaders, policymakers, entrepreneurs, and researchers, the forum creates opportunities for knowledge exchange, collaborative partnerships, and strategic dialogue aimed at solving pressing real-world challenges through research, technology, and education. In my keynote session, "Sustainable Development: Driving National Needs through Sustainable Innovations," I will emphasize the necessity of Sri Lankan-made innovations to meet local priorities in a manner that balances environmental stewardship, social well-being, and economic growth. True sustainability requires more than adopting global ideas—it calls for contextualized solutions that are resilient, relevant, and enduring in value. I wish to record my sincere appreciation to CINEC Campus, Dr Janaka Liyanagama, Chair and Prof. Sudesh Wijesinghe, Co-Chair and the Organizing Committee, for their leadership and commitment in bringing together such a meaningful event. It is a privilege to be part of this initiative, which not only reflects the aspirations of Sri Lankan engineers and researchers but also reinforces our global responsibility to shape a sustainable and innovative future. With my best wishes for the continued success of NEXORA and the lasting impact of CIRS2025.

Message from the Guest of Honour and Keynote Speaker | NEXORA
Non-Executive Director of HNB Assurance PLC, Prime Land Residencies PLC and
Mother Lanka Foundation / Senior Professor, University of Moratuwa.

Senior Prof. Ananda Jayawardane

It is a privilege to be associated with CIRS2025 and its flagship industry–academia forum, NEXORA: Industry–Academia Nexus. The symposium is a commendable initiative that goes beyond the boundaries of an academic gathering, creating a national platform to stimulate dialogue, collaboration, and knowledge exchange at a time when our country needs innovation-driven solutions. Throughout my career in academia, corporate leadership, and national policy institutions, I have witnessed how progress emerges when research excellence and practical application are brought together. NEXORA embodies this spirit by bringing corporate leaders, academics, policymakers, and young innovators into the same space to deliberate on challenges and opportunities that shape not only our industries but also our society. CINEC's commitment to sustaining such a dialogue is admirable, as it aligns research with the pressing needs of the nation, whether in construction, technology, finance, or education. By fostering closer ties between academia and industry, the symposium paves the way for research outcomes that are not confined to publications, but rather translated into impactful, real-world applications. The presence of distinguished experts from diverse disciplines will enrich the discourse, while the contributions of students and early-career researchers will provide fresh perspectives for a future-ready Sri Lanka. The entire symposium, therefore, is not only a showcase of intellectual achievement but also a strategic step towards strengthening our research culture and inspiring collaborative problem-solving. I warmly congratulate the organisers for their vision and dedication in creating this platform. It is my hope that the discussions initiated here will continue to resonate across institutions and industries, ultimately guiding our nation towards sustainable growth and global relevance.

Message from the Symposium Chair/
Dean - Faculty of Engineering & Technology

Dr. Janaka Liyanagama

It is with great honour and privilege that I extend this message as the Chair of the 6th CINEC International Research Symposium (CIRS2025). This year's symposium is organised under the timely and impactful theme, "Sustainability and Beyond: Unlocking the Power of Research." The theme was carefully chosen to reflect our collective responsibility to harness the transformative capacity of research in addressing the challenges of our time, while also envisioning a future that is resilient, inclusive, and sustainable. A significant milestone this year is the introduction of NEXORA, a high-impact industry–academia nexus that is integrated for the first time into the symposium. NEXORA was conceived to bridge the persistent gap between research and practice by bringing together corporate leaders, policymakers, entrepreneurs, and academics. This initiative aims to spark dialogue, foster partnerships, and create solutions that directly influence industries and communities. Equally important is the nationwide TriNova innovation competition, designed to empower and uplift the youth of our nation. By providing a platform to showcase their creativity and problem-solving capacity, TriNova not only encourages the next generation of innovators but also contributes to building a research-driven culture across the country. The Faculty of Engineering & Technology has played a pivotal role in this endeavour by fostering a culture of inquiry, innovation, and collaboration. Our faculty members and students have worked tirelessly to contribute their expertise, ensuring that this symposium remains a platform of both academic rigour and societal relevance. As Chair, I extend my heartfelt gratitude to the organising committee, faculty members, students, industry partners, sponsors, and volunteers who have made this two-day event possible. Your dedication and commitment have ensured that CIRS2025 will be remembered as a momentous occasion where research, innovation, and collaboration converge for the betterment of humanity.

Message from the Symposium Co-Chair/
Consultant Professor - Faculty of Engineering & Technology

Prof. Sudesh Wijesinghe

It is with immense pride and deep gratitude that I share this message as the Co-Chair of the 6th CINEC International Research Symposium (CIRS2025) come to life under the theme "Sustainability and Beyond: Unlocking the Power of Research." This theme carries profound meaning, for it reminds us that research is not only about discovery, but also about creating pathways that ensure resilience, inclusivity, and long-term impact for society and the planet. Over the years, my academic journey has shown me one simple truth: neither academia nor industry can thrive in isolation. To bring real impact, they must be intertwined, working hand-in-hand to generate knowledge, innovation, and solutions that matter. The realization of NEXORA, day one of CIRS2025, introduced this year as a landmark industry–academia nexus, is a testament to this vision. It is my firm belief that when academia shares its ideas, discoveries and capabilities and industry brings their needs and practical insights together with their resources. Eventually this synergy will unlock possibilities far greater than what either can achieve alone to cater national needs and boost nation's economy. I am truly delighted to see this vision materialize at CINEC, where NEXORA is already building bridges that will shape the future of research and practice in Sri Lanka and beyond. Another cornerstone of this symposium has been the unwavering commitment to quality in research. Excellence is my priority, and I am pleased that presentations for Day 2 of CIRS2025 were selected through a rigorous process, with over 400 submissions reviewed by academic and industry experts. This ensures the highest standards while strengthening research culture and collaboration at CINEC and nationally. I take this opportunity to honour the senior management of CINEC Campus for the trust and support, and the brilliant CIRS2025 organising committee members who tirelessly worked throughout to organise this unique but challenging event, which will eventually benefit a wide cross section. Special thanks to the industry sponsors, without their support, NEXORA would not be a reality. I also extend my heartfelt thanks to all the staff and students who contributed in various ways, reviewers and panel members of technical sessions.

"If everyone is moving forward together, then success takes care of itself" | Henry Ford

Message from the Symposium Co-Chair/
Dean - Faculty of Maritime Sciences

Capt. Prasanna Sedrick

It is with great pride and joy that I extend my warmest greetings to everyone participating in the 6th CINEC International Research Symposium CIRS2025. This year's main theme, "Sustainability and Beyond: Unlocking the Power of Research," truly reflects the spirit of innovation and progress that drives our community. As CINEC celebrates 35 years of excellence in maritime and higher education, we look back with gratitude at how far we have come since our establishment in 1990. For me, this milestone is deeply personal. I have seen CINEC grow from strength to strength, first as a 2nd batch cadet, and now as the Dean of the Faculty of Maritime Sciences and helping the Maritime Industry to grow in academia while holding the symposium, Co-Chair. It is a privilege to witness our 50th batch of Navigation Deck Cadets and the very first batch of BSc Maritime Operations Cadets present their work on this prestigious platform. Research is not just about discovery; it is about creating solutions that inspire change. This year, 12 abstracts will be presented under the sub-theme "Enhancing the Maritime, Logistics, and Hospitality Industry with Groundbreaking Research." Each represents a step toward a more sustainable, efficient, and innovative future. I encourage every participant student, researchers, and industry partners to approach this symposium not just as an academic exercise but as a space to exchange ideas, challenge norms, and build lasting collaborations. Together, we can continue to move beyond a graduate and nurture leaders who will transform the maritime industry and beyond. Let us celebrate this milestone with enthusiasm, curiosity, and a shared commitment to excellence. I look forward to seeing the impact of your research on our industry, our nation, and our world.

The Message from the Symposium Co-Chair/
Dean - Faculty of Marine Engineering

Chief Eng. Arjuna Ranasinghe

It is a great honor to share this message for CIRS2025, under the important theme "Sustainability & Beyond: Unlocking the Power of Research." This theme fits closely with our faculty's focus: "Sustainable Seas: Innovation in Marine Engineering for Efficiency and Safety." Today, the world faces serious environmental challenges, and the oceans are a big part of that picture. As marine engineers, we have a special role to play in protecting the seas while making ships and marine systems safer and more efficient. This means finding new ways to reduce pollution, save energy, and build safer technologies. Research and innovation are the keystones of this journey. From cleaner propulsion systems and energy-efficient vessels to advanced materials and digital monitoring technologies, our field continues to evolve in response to both ecological imperatives and operational demands. But sustainability is not solely a technical challenge; it is also a societal responsibility. We must engineer not just for performance, but for the planet and for future generations. CIRS2025 is a wonderful opportunity for researchers, students, and professionals from many fields to come together, share ideas, and build strong connections. I encourage everyone to be open, curious, and creative during the symposium. Your work and ideas can help shape a better, more sustainable world. Let us continue to move forward with innovation, teamwork, and a strong commitment to the environment. Together, we can build a future where our oceans are healthy, our technology is smart, and our research creates real and lasting change. Wishing you all a successful and inspiring symposium.

Message from the Dean - Faculty of Health Sciences

Senior Prof. Menik Hettihewa

It is with great pride and anticipation that I extend my warmest welcome to all distinguished researchers, academics, industry partners, and students gathered here for the CINEC international Research Symposium, 2025. This research symposium is not merely an academic gathering, but a vibrant arena where curiosity meets creativity, and knowledge transforms into innovation. In today's rapidly evolving world, research is the compass that guides us through uncertainty and complexity, illuminating pathways to solutions that shape the future of our societies, industries, and nations. At Faculty of Health Science, we strongly believe that research is more than the pursuit of answers - it is the foundation for transformation. It empowers us to bridge disciplines, break traditional boundaries, and forge collaborations that extend beyond geographical borders. The themes explored at this symposium—from sustainable technologies, healthcare innovation, maritime advancements, digital intelligence, and beyond—represent not only the intellectual strength of our community but also the pressing needs of our time. As the Dean, I am inspired by the passion and commitment of our scholars, both emerging and established, who continue to demonstrate that impactful research is built on resilience, curiosity, and collaboration. The insights shared at this forum will undoubtedly contribute to national development goals, regional progress, and global knowledge advancement. Let this symposium be a catalyst for bold ideas, transformative partnerships, and groundbreaking discoveries. May it ignite in all of us the conviction that research is not confined to laboratories or libraries, but is a living, breathing endeavor that shapes the human experience. On behalf of Faculty of Health Science, I thank you for your participation and contribution to this extraordinary journey. Together, let us make CIRS2025 a milestone in academic excellence and international collaboration.

Message from the Dean - Faculty of Management and Social Sciences

Chair Prof. (Dr.) Lalith Edirisinghe

It is with immense pleasure that I welcome you to CIRS2025, held under the theme "Sustainability & Beyond: Unlocking the Power of Research." This conference is a timely platform to share knowledge, strengthen academia–industry collaboration, and inspire innovative solutions to global challenges. At the Faculty of Management and Social Sciences, CINEC Campus, we emphasize educational vertical integration, from the school education to industry and society through a sustainable degree pathway. This ensures continuity of learning and supports the development of critical thinking, scholarly research, and innovation in most critical and evolving subject areas. Our graduates are empowered not only to succeed as professionals but also to become leaders and change-makers who can shape industries and communities. The theme of sustainability is central to our mission. We believe education must go beyond imparting knowledge to instill responsibility, resilience, and creativity. Through research and dialogue, CIRS2025 will explore solutions that benefit both society and industry, especially in areas such as supply chain, logistics, and tourism. I warmly welcome all participants and look forward to the collaborations and insights this event will generate.

Message from the Dean - Faculty of Humanities and Education

Dr. Sujeewa Polgampala

On behalf of the Faculty of Humanities and Education, it is with profound honor that I extend a warm welcome to the 6th CINEC International Research Symposium. This year's theme, "Sustainability and Beyond – Unlocking the Power of Research," is exceedingly pertinent and resonates profoundly with our institutional mission. It impels us to transcend purely technical paradigms and grapple with essential anthropocentric questions: What is our collective vision for the future? How do we cultivate justice, equity, and cultural resilience within an increasingly interconnected global community? Our academic endeavors are intrinsically guided by this human-centric ethos. The pioneering research being presented today encompassing environmental justice, pedagogical innovation, technological ethics, and cultural heritage underscores that genuine sustainability is not merely an ecological imperative but a multifaceted social, cultural, and educational endeavor. This corpus of work exemplifies the indispensable synthesis of disciplines, affirming that the resolution of our most pressing global challenges necessitates interdisciplinary approaches firmly rooted in human understanding. This symposium serves as a catalytic platform for the very collaboration and innovation our world urgently requires. The discourse and connections cultivated within this forum will be instrumental in guiding us beyond mere sustainability toward a regenerative, equitable, and profoundly human-centered future. I embrace immense pride in the scholarly contributions of our faculty and anticipate with great expectation the meaningful dialogue and fruitful collaborations poised to emanate from our collective engagement with the whole CINEC family. Thank you for your invaluable participation in this truly collective pursuit. Your steadfast backing is indispensable as we deeply quest for knowledge and transformative transformation for the betterment of our world and all its inhabitants.

The Message from the Dean - Faculty of Science

Prof. Samantha Weerasinghe

I am delighted to welcome you to the 6th CINEC International Research Symposium (CIRS2025), held under the theme "Sustainability and Beyond – Unlocking the Power of Research." This theme captures the essence of what research must achieve in our time: the ability to seek knowledge that not only explains the present but also shapes a future where development and sustainability move hand in hand. The Faculty of Science is proud to contribute to this important forum. Research is central to academic life, and it thrives when scholars are given opportunities to share their work, receive constructive feedback, and build collaborations. This symposium provides exactly such a platform, where participants from diverse backgrounds gather to exchange ideas, test new approaches, and inspire one another. Whether in fundamental or applied domains, each study presented here reminds us of the broader responsibility of science: to advance knowledge while also serving society. The theme of sustainability further challenges us to think beyond traditional boundaries and to ensure that the outcomes of our research benefit not just today's communities, but generations to come. I extend my sincere appreciation to the authors, reviewers, chairs, and the organizing committee whose collective dedication has brought this symposium to life. I also thank our partners in academia and industry who continue to support and strengthen this endeavour. May CIRS2025 be a space where ideas take root, collaborations flourish, and a renewed commitment to research excellence is fostered. I wish all participants two days of stimulating presentations, meaningful discussions, and lasting connections.

Message from the Associate Dean – Faculty of Computing

Ms. Suranji Nadeeshani

It is with immense pleasure that I send this message to the Annual International Research Symposium of CINEC Campus (CIRS2025) hosted by the Faculty of Engineering and Technology. In line with the main theme of CIRS2025, "Sustainability and Beyond - Unlocking the power of research" Faculty of Computing has selected the subtheme "Empowering Community Sustainability through Data-Driven Insights in ICT Research". The work being showcased today by the students of the Faculty of Computing spanning across Data Science, Big Data, Artificial Intelligence, Machine Learning, Human Computer Interaction, Image Processing, Network and Cyber Security and few other emerging areas in industry. CINEC International Research Symposium is serving as a premier platform for our students, staff and scholars to share their knowledge and create strong bond with the industry for their future innovations. This year's symposium has created a great networking opportunity for our students to make connections with the industry by introducing NEXORA: the Industry-Academia collaboration platform. A symposium should not be merely a presentation of projects. It is an important event where theoretical knowledge meets practical application and where the experienced academics and scholars create the next generation of inventors. I extend my deepest gratitude to the staff members of the faculty for their guidance, to our industry partners for their collaboration, and most importantly, to our students for their dedication. Your hard work is the key success factor in this event. Be proud of what you have accomplished. This book is a testament to your hard work. Let this symposium be a new beginning for the innovative ideas and collaborations that will shape the future of our world.

Congratulations on the successful Symposium 2025!

Keynote Address Summary | *Upcycling for Sustainable Development*
CIRS2025 Technical Sessions
Professor of Materials Science, Department of Physics, University of Colombo.

Prof. Dilushan R. Jayasundara

In today's world, where human activity is expanding exponentially, the demand for resources is fast approaching a critical threshold. Under these circumstances, using resources sustainably often merely buys time rather than truly easing the strain on them. This makes it imperative to explore alternative approaches such as upcycling that has the potential to decouple human wellbeing and economic growth from resource consumption.This talk will highlight the use of an upcycled waste material from one industry to treat waste generated in another, under the concept of "waste to treat waste." This technology not only prevents the accumulation of waste in the first industry but also reduces the need to import treatment materials for the second, which would otherwise become additional waste. This approach thus delivers both environmental and economic benefits, while supporting sustainable growth across industries. In addition, the presentation will address solutions to postharvest losses and nano- and microplastic contamination using natural mineral-based composite materials. Finally, it will examine the critical role of researchers in advancing scientific innovation to safeguard human, environmental, and economic well-being.

Technical Sessions

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Experimental Investigation on Subgrade Reinforcement Using Geosynthetics

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Introduction: In Sri Lanka, Construction Industry Development Authority (CIDA) mandates a 4-day soaked California Bearing Ratio (CBR) value above 5% for subgrades in road construction. Most subgrades fail due to weak soil properties, requiring treatments like soil stabilization or replacement. However, these conventional methods are often costly and unsustainable. This study explores geosynthetics as a more efficient and environmentally friendly solution to enhance subgrade performance in a sustainable manner.

Objectives: To develop a relationship between CBR values of subgrade material and Moisture Content (MC). To determine the effect of geosynthetic strength on improvement of subgrade characteristics. To determine the effect of location of geosynthetic on improvement of subgrade characteristics.

Methodology: A series of 4-day soaked CBR tests were conducted at varying moisture contents. Additionally, plate load tests were performed on seven pavement models with geosynthetic layers positioned at different levels within the subbase and at the subgrade-subbase interface.

Results & Discussion: The results revealed a predictive model for the utilized soil (CBR = 10.824e-0.066MC) indicating CBR decline with increasing moisture. A single geosynthetic layer at the subgrade-subbase interface enhanced the ultimate bearing capacity of weak subgrade by over 70 %, while adding two layers improved it by 135 %. However, increasing geosynthetic strength alone did not yield significant gains. Notably, placing the second layer in the upper third of the subbase was more effective than placing it at the center.

Conclusion: Using geosynthetics at the subgrade-subbase interface can improve weak subgrade CBR values to meet CIDA standards and reduce vertical stress by over 50 %, minimizing settlement while enhancing road durability.

Keywords: California Bearing Ratio, Geosynthetics, Subgrade

Automated Rainwater Harvesting and Municipal Water Switching System for Sustainable Non-Potable Water Use in Industrial Facilities

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Introduction: Water scarcity and rising costs necessitate sustainable water management in Sri Lankan industries. Rainwater Harvesting (RWH) for toilet flushing is a promising eco-friendly solution, but manual switching between sources reduces efficiency. This study presents the design and analysis of an automated system to optimize water use, improving sustainability and cost savings.

Objectives: The aim was to design an automated system that prioritizes harvested rainwater for toilet flushing and switches to municipal supply when depleted, thereby reducing reliance on public water, achieving economic savings, and promoting sustainable industrial practices.

Methodology: The system, designed in SolidWorks, uses a hydrostatic sensor in a 100,000 litre tank to provide real-time data to a KiCAD 7.0–verified controller that operates solenoid valves for automatic switching between rainwater and municipal supply. Non-return valves ensure hygiene and safety. Historical rainfall data from the Sri Lankan Department of Meteorology was used for performance simulation, while annual water savings and payback periods were estimated using local hardware costs and National Water Supply and Drainage Board tariffs.

Results & Discussion: Simulations showed a 5.5% reduction in municipal water usage, saving about 30,000 litres daily in a modelled 2,000-person facility. Monsoon season savings exceeded 500 m^3, producing an annual cost reduction of LKR 75,000. The system achieved a payback period of 6.5 years, demonstrating strong economic feasibility. Simulations confirmed reliable operation and effective backflow prevention, validating the design's technical viability.

Conclusion: The study demonstrates the feasibility of automated RWH in Sri Lankan industries, offering environmental and economic benefits. Limitations include the lack of prototype validation. Future work will focus on system prototyping, IoT-based monitoring, and water quality integration to enhance performance and applicability.

Keywords: Automated switching, Feasibility study, Rainwater harvesting, Sri Lanka, Water conservation

Adjustable Multi-Cup Sealing System for Cost-Effective Packaging in the Food Industry

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Introduction: The food and beverage industry requires hygienic, durable, and flexible packaging systems. Conventional cup sealers are mostly fixed-diameter, forcing manufacturers to invest in multiple units or make manual adjustments that increase downtime. Existing adjustable sealing machines are costly and not well-suited for small- to mid-scale industries. This study introduces an adjustable sealing machine capable of handling cup diameters from 70 mm to 100 mm, providing a cost-effective and space-saving solution.

Objectives: This study will entail (a) developing a cost effective but flexible sealing mechanism, (b) minimizing redundancy of equipment costs, (c) assessing the mechanical performance and heat conduction capability of the structure through simulation and prototype, (d) determining the best materials that balance the strength, conductivity and cost.

Methodology: A modified three-jaw clamping mechanism with interchangeable sealing inserts was designed in SolidWorks. Aluminum 3003 alloy was chosen for its machinability and thermal conductivity, with stainless steel considered for comparison. Finite Element Analysis (FEA) was performed to analyze stress, displacement, and thermal deformation. Fatigue and dynamic load aspects were also assessed. A PVC-based prototype with steel rivets was fabricated and tested across three cup sizes to validate sealing consistency.

Results & Discussion: FEA revealed a maximum von Mises stress of 4.14×10^7 N/m^2 at the jaw–clamp interface and a displacement of 0.025 mm at the mid-span, both within safe limits. Fatigue analysis suggested durability under repeated sealing cycles. Prototype testing confirmed reliable sealing across all target diameters. Instead of precise cost reporting, findings suggest potential 30–40% savings compared to purchasing multiple fixed-diameter machines.

Conclusion: The system demonstrates promising adaptability and technical feasibility for small- to mid-scale applications. Its novelty lies in combining wide-range adjustability with validated structural and thermal performance. Future improvements should address long-term fatigue testing, automation of adjustments, and composite material integration for industrial-scale durability.

Keywords: Adjustable cup sealer, Automation, Finite Element Analysis, Food packaging technology, Heat sealing

A Highly Precise Drone Localization Algorithm Using Ultra-Wideband for Global Navigation Satellite System Denied Environments

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Introduction: Global Navigation Satellite System (GNSS) denied environments, such as indoors, urban canyons, and forests, pose major challenges to autonomous drone navigation due to signal obstruction and multipath. Conventional indoor localization methods (Wi-Fi, Bluetooth, visual odometry) suffer from low precision, delay, or environment reliance. This work addresses these issues by developing a drone navigation system based on Ultra-Wideband (UWB) technology with centimeter-level positioning accuracy without satellites.

Objectives: To develop a UWB-based independent drone navigation system that has highly accurate positioning in areas where GNSS signals may not receive.

Methodology: Four ESP32-based UWB anchors (DW1000) and one mobile tag estimated drone position via trilateration. A Kalman filter minimized UWB noise and offered positional stability with a two-dimensional state vector (position and velocity) and process and measurement noise covariance matrices were empirically tuned. Filtered output was converted into NMEA-standard GPS sentences by a custom "fake GPS" module for compliance with the Pixhawk flight controller. Indoor field experiments within a 10 m × 10 m indoor arena under various interference conditions tested Root Mean Square Error (RMSE), Mean Absolute Error (MAE) and standard deviation, and compared results with Wi-Fi Received Signal Strength Indicator (RSSI) and Bluetooth beacon localization.

Results & Discussion: Raw UWB data achieved a RMSE of 0.94 m, MAE of 0.76 m and a standard deviation of 0.54 m. After Kalman filtering, errors were reduced to 0.23 m, 0.22 m and 0.06 m respectively with improvements of 76%, 70% and 90%. Compared to Wi-Fi ($\approx$2.3 m RMSE) and Bluetooth ($\approx$1.8 m RMSE), the proposed system achieved much higher accuracy and lower variability. The Kalman filter optimally fused consecutive noisy measurements, producing smoother, more reliable trajectories for autonomous flights.

Conclusion: The study demonstrates the effectiveness of a UWB-based autonomous drone navigation system in GNSS-denied environments with high accuracy and stability. Future enhancements could incorporate deep learning - based prediction models to further improve positioning accuracy and robustness against environmental challenges.

Keywords: Drone navigation, Global Positioning System, Kalman filter, Ultra-Wideband

An Affordable, Highly Precise Drone Navigation and Inventory Management System for Optimizing Indoor Warehouse Operations

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Introduction: Warehouse inventory control is often plagued by labor-intensive and error-prone manual operations. Existing warehouse automation technologies using fixed Automated Guided Vehicles (AGVs), Radio Frequency Identification (RFID), or vision navigation, this work proposes a Ultra Wide-band (UWB) enabled drone system that optimally integrates aerial navigation, real-time location system, and robotic warehousing handling. The system is more flexible and economical for small and medium-sized warehouses.

Objectives: To develop an affordable, highly precise UWB based drone navigation and inventory management system for optimizing the operations of indoor warehouse.

Methodology: A custom-built quadcopter drone with a 450 mm glass fiber frame was designed for indoor warehouse use, powered by 1000 kV brushless motors, 30 A ESCs, and a 3-cell Li-Po battery, capable of carrying up to 1 kg payload. Its flight dynamics were simulated in MATLAB-Simulink for performance evaluation. To enable indoor navigation without Global Navigation Satellite System (GNSS), a DW1000 UWB-based localization system was implemented on a Raspberry Pi 4B to estimate the drone's 3D position, which was fused with onboard IMU and barometer data on the Pixhawk 4 flight controller. A web camera with OpenCV handled QR scanning for inventory updates, while an ESP32 controlled servo grabber managed item handling. Inventory data was monitored and updated through a custom GUI linked to a MySQL database for real-time management.

Results & Discussion: Simulation and indoor testing showed consistent flight with payloads of up to 1 kg, with stable control and minimal drift to 6 m in altitude. The UWB based localization system has more than 95% positioning accuracy under controlled indoors, validated against fixed ground marks in a 10 m × 10 m test room. QR-based stock logging was maintained over 95% detection sensitivity in 50 controlled experiments with standardized QR sizes.

Conclusion: This work illustrates a real-world solution to the automation of warehousing inventory monitoring in indoor storage space through the employment of UWB-enabled drones. The system's precision, affordability, and modularity render it suitable for small- and medium-sized enterprises that seek to maximize logistics efficiency at reduced operation costs.

Keywords: Drone navigation, Inventory management, Ultra-Wideband, Warehouse automation

Optimized Microstrip Patch Antenna Array Design for Enhanced Beamforming in Telecommunication Systems

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Introduction: Conventional single element Microstrip Patch Antennas (MPAs) suffer from low gain and limited directional control. Antenna arrays address these limitations but often exhibit high Sidelobe Levels (SLLs), which degrade system performance. Suppressing sidelobes is crucial in applications requiring directional precision and interference mitigation.

Objectives: This work aims to design and optimize a microstrip patch antenna array for improved beamforming, sidelobe suppression, and overall performance in telecommunication systems.

Methodology: A uniform linear four element microstrip patch antenna array was designed for 2.4 GHz using FR-4 substrate. A Real-Coded Genetic Algorithm (RCGA) was employed to optimize inter-element spacing, amplitude excitation, and phase excitation over 100 generations. The composite objective function integrated return loss, Voltage Standing Wave Ratio (VSWR), gain, and sidelobe suppression to achieve balanced performance. To ensure practical implementation, a corporate feed network incorporating quarter-wave transformers and T-junctions was designed for equal power distribution. The complete structure was fabricated on FR-4 using manual etching.

Results & Discussion: The optimized array achieved a return loss of –32.6 dB, VSWR of 1.047, gain of 8.19 dBi, and sidelobe suppression of –15.1 dB, outperforming the non-optimized array and single patch. These improvements demonstrate the RCGA's effectiveness in balancing tradeoffs between gain, impedance matching, and radiation control. However, future work may extend to multi-algorithm ensembles to ensure broader solution consistency. Beyond the ISM band, the design principles are applicable to Wi-Fi, IoT, and directional telecom links.

Conclusion: This study validates RCGA-based optimization as an effective strategy for enhancing antenna array performance. The approach offers a scalable and adaptable solution for next-generation high-performance communication systems.

Keywords: Antenna array, Beamforming, Genetic algorithm, Microstrip Patch Antenna, Sidelobe suppression

Edge-Computing Enabled Gesture Recognition Platform for Undergraduate Learning Environments

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Introduction: Natural gesture recognition allows intuitive interaction but usually depends on cameras and cloud processing, limiting mobility. Edge computing enables on-device data processing, yet undergraduate programs lack an affordable, hands-on platform to teach real-time gesture classification on constrained microcontrollers.

Objectives: Design and implement a low-cost wearable gesture recognition device that also functions as a modular edge-computing learning platform, demonstrating both technical feasibility and educational value.

Methodology: The device captures six-axis IMU data at 100 Hz and integrates an OLED display and peripheral modules for tutorials. Ten volunteers each performed 25 four-second trials of four gestures: Pinch, Pan, Lift, and Idle, yielding 7200 one-second windows. Continuous signals were segmented into non-overlapping one-second windows to avoid data leakage between the training and test sets. Frequency features were extracted using a 64-point FFT and used to train a compact feed-forward neural network with 78 input features, two dense layers (20 and 10 neurons) with dropout, and four outputs ($\approx$1,834 parameters). The model was trained with Adam (learning rate 0.0005, batch size 32, 30 epochs) and quantized for deployment.

Results & Discussion: The quantized int8 model achieved 97.7% validation accuracy, while the float32 model reached 99.0% on a held-out test set. The modular platform (<$50) lets students retrain with new gestures and add or remove modules, supporting active, cost-effective learning compared to camera-based systems.

Conclusion: Future work will expand gesture diversity, validate robustness with larger student cohorts, and optimize latency and energy efficiency, reinforcing its role as a scalable teaching tool for embedded ML.

Keywords: Edge computing, Fast Fourier Transform, Gesture recognition, Inertial Measurement Unit

Power Tile: Optimized Electromechanical Conversion for Enhanced Footstep Energy Harvesting

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Introduction: The need for sustainable energy collecting systems is highlighted by the rising global energy demand and environmental concerns. By introducing "Power Tile," a kinetic energy harvester that transforms human footprints into electrical energy for urban applications, this study overcomes the drawbacks of traditional piezoelectric systems.

Objectives: Design a robust, sustainable high efficiency energy harvesting system using a stepper motor.

Methodology: The design phase involved comparative analysis of transduction methods, leading to the selection of a stepper motor for its superior torque and power density. The mechanical design incorporates a gear train to amplify angular velocity input to the generator. Electrical output is conditioned through a full wave bridge rectifier and a 4800 uF capacitive filter bank to minimize the ripple voltage, ensuring stable battery charging. Quantification of the systems electromechanical conversion efficiency was performed under calibrated compressive loads.

Results & Discussion: At the maximum load (100 kg), the system's conversion efficiency was 40%, exhibiting a predicted nonlinear force-voltage relationship (2-8.56V output). Firmware-based signal filtering and better gear ratios reduced mechanical losses. USB device charging and motion-activated night lighting, which modifies brightness based on ambient light detection, were examples of successful applications. With the flexibility to scale through multi-tile arrays, the modular design demonstrated special promise for urban installations with heavy traffic.

Conclusion: For smart buildings, Power Tile provides a reliable and effective substitute for piezoelectric harvesters. In order to improve sustainable urban energy solutions, future research will investigate IoT integration and widespread deployment.

Keywords: Efficiency, Electromechanical, Foot traffic, IoT, Kinetic Energy

Real-Time Condition Monitoring of Vehicle Engine Driving Belts through Acoustic Emission and Edge-Computing Techniques

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Introduction: Early detection of faults in vehicle engine driving belts is critical for predictive maintenance, as undetected issues can lead to significant operational disruptions and costs. Acoustic Emission (AE) technology is particularly suitable for detecting belt-related faults due to its sensitivity to subtle changes in acoustic patterns caused by mechanical anomalies, providing an effective non-invasive diagnostic solution.

Objectives: Develop a portable, real-time monitoring device using acoustic emissions integrated with edge computing for predictive maintenance targeting vehicle engine driving belts.

Methodology: An Arduino Nano 33 BLE Sense Rev2 with a built-in microphone was used with a custom rig comprising a universal motor (PID-controlled via triac) and a V-ribbed belt (3 ribs, 815 mm). Tests simulated healthy, loosened, and worn belt conditions at 800 RPM. 10-s recordings were segmented into 2-s .wav samples (70 KB) with 500 ms window and 250 ms overlap, producing over 200 samples per condition. Data was processed using Mel Filter-Bank Energy (MFE). A 1D Convolutional Neural Network (CNN) was selected for its feature extraction efficiency and robustness to noise, offering higher accuracy and edge deployment suitability than Support Vector Machine (SVM) or Random Forest (RF). Preprocessing included segmentation, normalization, and an 80/20 train-test split.

Results & Discussion: CNN achieved 96.8% validation accuracy and 93% real-time accuracy. On the validation set, weighted precision/recall/F1 were 0.98; the test set weighted precision/recall/F1 were 0.95. Confusion matrices confirmed strong classification (Healthy 86.2%, Worn 95.5%, Ideal 100%). Noise robustness was evaluated in controlled variations (quiet, conversation, heavy noise), showing resilience without advanced suppression.

Conclusion: The proposed device offers an effective, real-time predictive maintenance solution for engine belt fault detection using AE and edge computing. While current tests are limited to a lab rig and a single belt type, future work will extend trials to real vehicles, multiple belt types, and additional engine components.

Keywords: Acoustic Emission, Edge Computing, Embedded System, Fault Detection, Machine Learning

Improving Indoor Communication through Optimized Visible Light Communication Technology

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Introduction: Visible Light Communication (VLC) leverages LED lighting for high-speed wireless data transfer, offering advantages like immunity to RF interference and dual-purpose illumination. While white LEDs are commonly used, their phosphor coating limits bandwidth due to slow conversion delays. Blue LEDs (455–495 nm) bypass this bottleneck, enabling faster modulation and higher data rates. This project optimizes a blue LED-based VLC system for indoor environments, focusing on improving SNR via signal processing, and ensuring reliability against multipath interference and ambient light noise. The results demonstrate blue LEDs' superiority, achieving a higher SNR than white LEDs, paving the way for next-gen optical wireless networks.

Objectives: To optimize the performance of indoor VLC systems using blue LEDs to achieve higher data rates and reliable communication

Methodology: A software-based simulation framework was developed to model a room environment. Key parameters were analyzed with the intension of optimizing the indoor communication. An algorithm was employed to optimize Signal-to-Noise (SNR) distribution. Hardware components utilized for the system, includes with LEDs, photodiode and microcontroller.

Results & Discussion: Simulation results demonstrated that blue LEDs provide a more efficient distribution, with a peak illuminance resulted in an improvement in SNR, achieving blue LEDs, significantly higher than the white light LED systems.

Conclusion: The study concludes that blue LEDs outperform white LEDs in VLC systems Future work includes advanced hardware testing, hybrid VLC systems combining blue and white LEDs, and integration with machine learning for dynamic optimization. These findings contribute to the development of reliable, high-speed indoor communication solutions.

Keywords: Algorithm, Blue LED, Indoor communication, Signal to Noise Ratio, Visible Light Communication

Optimizing Predictive Maintenance through Edge Computing Enabled Condition Monitoring Device: A Portable Solution

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Introduction: Early detection of bearing faults is essential but often inaccessible to Small and Medium Enterprises (SMEs) due to the cost and complexity of cloud-based monitoring systems. This project addresses that gap by developing a portable, edge-computing-based device to enable real-time predictive maintenance using vibration analysis.

Objectives: To develop and deploy a lightweight, energy-efficient edge-computing solution for classifying bearing faults using vibration data, implemented on a portable device capable of real-time and offline condition monitoring.

Methodology: A modified Welling washing machine motor was used to test 6202 bearings under healthy and outer race fault conditions. An ADXL345 accelerometer mounted on the housing recorded vibration signals at 3000 Hz, with ten 10-second recordings per condition. Signals were bandpass filtered, normalized, and segmented into 1-second windows with 50% overlap. Spectral analysis was applied to extract frequency-domain features, which trained a lightweight CNN for two-class classification. The model was deployed on an Arduino Nano BLE 33 Sense and evaluated for accuracy, inference latency, and energy consumption in real-time monitoring.

Results & Discussion: A lightweight Convolutional Neural Network (CNN) was designed and trained using an 80/10/10 split for training, validation, and testing. The model achieved 86.5% classification accuracy with balanced precision and recall across the two classes. The trained model required less than 200 KB of memory and fewer than 50k parameters, making it deployable on an Arduino Nano BLE 33 Sense. In real-time tests, the system achieved an inference latency of 92 ms per window and consumed only 0.18 W during active monitoring, confirming its lightweight and energy-efficient operation.

Conclusion: The proposed solution provides a cost-effective and portable alternative to cloud-based monitoring, enabling real-time fault detection in resource-constrained environments. Its independence from external infrastructure makes it suitable for SMEs and remote industrial setups, facilitating broader adoption of predictive maintenance technologies.

Keywords: Bearing faults, Condition monitoring, Edge computing, Predictive maintenance, Vibration analysis

Mini Voice Communication Switching System for Air Traffic Control Centers

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Introduction: In air traffic management, voice communication systems are vital for safety and efficiency. Existing analog systems are often expensive and complex, making them unsuitable for domestic airports that handle low air traffic. To overcome these issues, a cost-effective, Internet Protocol (IP)-based Mini Voice Communication Switching System (VCSS) was introduced, since it allows integration of voice and data over a single network, reducing infrastructure costs and simplifying maintenance.

Objectives: Design a standalone, mini VCSS that can be used in domestic airports. While reducing infrastructure complexity and costs relative to the existing system. To ensure seamless coordination, interoperability, and long-term sustainability of a domestic airport operation.

Methodology: VCSS was developed by using Asterisk open-source VoIP software hosted on a virtualized Ubuntu server. The Session Initiation Protocol (SIP) and the Dialplan of the server were configured according to the requirement of the VCSS. Soft phones (Endpoints) were connected via Wi-Fi to the server according to the relevant protocols. Analog phones were integrated via a media gateway and the IP phone directly to the server. For the CWP a web-based click-to-call interface was implemented by using Asterisk Call Manager Interface (AMI). All the equipment's are connected and configured in a Local Area Network (LAN) architecture. Finally, the system performance was measured by using Wireshark whether it fulfills the International Civil Aviation Organization (ICAO) and Eurocae standards.

Results & Discussion: The prototype was able to connected different analog and digital communication equipment's to the VCSS server and controlling via the CWP. As per the international required standards, prototype was able to achieved an average one-way delay below 100ms, jitter under 50ms, and packet loss below 3% of VoIP communication performance.

Conclusion: IP- based VCSS offers a reliable and affordable solution for domestic Air Traffic Control (ATC) centers which was implemented by using open-source platforms and standard protocols. In future, this system can be developed to communicate between ground to air which the controller can directly contact with the aircraft.

Keywords: Air traffic control, Asterisk manager interface, Controller working positions, Dialplan, Session initiation protocol

Smart Wearable Assistive Device with Integrated Indoor Localization for Deaf Individuals with Visual Notification and Vibrational Feedback

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Introduction: Hearing-impaired individuals face difficulties in public environments such as airports, where missed auditory announcements create safety risks and limit independence. Existing solutions use basic amplification and large screens providing only generalized messages. The developed system uniquely combines Wi-Fi indoor localization, health monitoring, and bidirectional communication to deliver personalized notifications and navigation instructions, distinguishing it from conventional public messaging systems through individualized feedback.

Objectives: To provide a convenient and accessible solution for monitoring and communicating with deaf individuals in public spaces, facilitating real-time position identification, tactile feedback, and message transmission through an assistive device.

Methodology: An ESP32-based device was designed with Wi-Fi localization using Received Signal Strength Indicator (RSSI) trilateration, Weighted Least Squares (WLS) and SPAN threshold filter achieving under 1.5m accuracy. A pulse sensor monitors user health status while MQTT enables two-way communication via HiveMQ Cloud. Two devices were tested in an 8.5m x 12.5m environment. User feedback received to Node-RED dashboards, was analysed for usability and performances across multiple scenarios.

Results & Discussion: After testing, an average positioning error of about 1m was found, with 80% of results under 1.5 meters. 95% accuracy was achieved by pulse sensor with successful message transmission. Sensitivity was affected by environmental factors such as Wi-Fi interference in crowded areas, metal structures affecting RSSI readings, and varying performance across different architectural layouts. Continuous operation of the device was limited to 9-10 hours depending on the battery capacity.

Conclusion: The Device can improve the quality of life of deaf individuals, despite scalability and battery restrictions. Extensive Wi-Fi access point mapping and site-specific calibration procedures need to be considered when scaling up the device. Enhancements like Kalman filtering could improve accuracy for inclusive design.

Keywords: Deaf accessibility, Indoor localization, Real-time Tracking, Tactile feedback

Voice Operated Smart Notice Board: A Speech-Driven Embedded System for Public Information Access

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Introduction: Conventional notice boards require manual updates and physical interaction, limiting accessibility and responsiveness. This study introduces a voice-operated smart notice board that integrates speech recognition with AI-driven real-time information retrieval, enabling hands-free access to institutional services and navigation support.

Objectives: To design and implement a Raspberry Pi–based embedded system for voice-controlled notice boards, incorporating AI to provide real-time institutional information, and to evaluate its performance in terms of recognition accuracy, latency, and user usability.

Methodology: The system was developed on a Raspberry Pi 4 (4 GB RAM) with an HDMI display and a USB condenser microphone (FIFINE K669B). Users speak queries directly to the Voice Operated Smart Notice Board, and the input is converted to text using the VOSK engine integrated via the SpeechRecognition library, ensuring offline functionality. The recognized text appears in the search bar, after which the Flask backend processes the command with lightweight NLP to retrieve relevant results. A ReactJS frontend displays the retrieved information dynamically. Performance was evaluated across 400 command trials in quiet and moderately noisy indoor environments. Latency was measured from voice input to display, and usability was assessed via structured feedback from undergraduate participants (n = 50, aged 20–26).

Results & Discussion: Recognition accuracy reached 91.3% in quiet environments and 84.5% under moderate noise. Average response latency was 2.1 s, with CPU utilization peaking at 42% and memory usage below 150 MB. False activations occurred in 3.5% of trials. While conventional embedded speech systems typically report 88–90% accuracy, the proposed design extends capability by coupling speech recognition with AI-based real-time information retrieval, achieving reliable performance for institutional use. Usability feedback from undergraduate participants highlighted improved accessibility and ease of interaction in a university context (CINEC case study).

Conclusion: The system demonstrates the potential of combining voice interfaces with AI-based retrieval for institutional notice boards. Future work will enhance noise robustness, personalization, and offline database integration to support wider deployment

Keywords: AI integration, Embedded system, Raspberry Pi, Smart Notice board, Speech recognition

Design and Implementation of an RFID-Enabled Smart Checkout Sorting System for Retail Automation

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Introduction: Manual barcode scanning and human-based classification slow retail checkout and increase errors. Radio-Frequency Identification (RFID) with Internet of Things (IoT) integration offers a path to faster, more accurate, and less labor-intensive retail operations.

Objectives: To develop and evaluate an RFID-IoT smart checkout system that accelerates transactions, improves sorting accuracy, and enhances inventory control while remaining cost-effective and scalable.

Methodology: The prototype employs an ESP32 microcontroller with custom Arduino-based firmware communicating to a web dashboard via MQTT over Wi-Fi. A 13.56 MHz reader with circular-polarized antenna scans UID-changeable MIFARE Classic S50 NFC stickers (Block-0 rewritable, 10 stickers for 290 LKR $\approx$ 29 LKR each) attached to products. Dual conveyor belts move items past infrared sensors; SG-9 micro servo motors (5 V, $\approx$ 2.5 kg.cm torque) actuate gates to sort into four categories: fruits/vegetables, beverages, health/beauty, and packaged foods. The firmware handles ISO 14443A anti-collision and streams item data and pricing to the dashboard in real time.

Results & Discussion: Testing involved 10 tagged products—one per category—across multiple passes to validate consistency. The system achieved 98% classification accuracy and reduced average checkout time by $\approx$ 40% compared with manual barcode scanning. Simultaneous tag reads were reliably processed without collisions. Preliminary costing shows low tagging expense and an estimated payback of under 18 months for a medium-size store.

Conclusion: This RFID-IoT checkout sorter delivers faster transactions, high accuracy, and improved inventory visibility. Future work will extend to larger product sets and integrate PLC-based control for industrial-scale deployment.

Keywords: Automated checkout, Internet of Things, Radio Frequency Identification, Smart sorting

Blockchain Based Real Estate Trading Platform

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Introduction: The traditional real estate transactions in Sri Lanka are encountered with higher costs, lengthy procedures, dependence on intermediaries and lack of transparency. Existing digital systems remain centralized and fail to resolve these challenges. Due to the inherent decentralization, transparency, and immutability of blockchain technology, the above issues can be eliminated. This study investigates a real estate trading platform integrating blockchain, smart contracts and tokenization, providing a novel approach to digital property transactions.

Objectives: The primary objective is to design and develop a blockchain-enabled system where secure, efficient and transparent real estate transactions can be performed through smart contracts that support user-friendly features of the digital property ownership, fractional ownership and decentralized decision making.

Methodology: A customized blockchain is developed with C++, SHA-256 hash and a Proof-of-Work consensus mechanism. Truffle and Remix are used to deploy Ethereum-compatible smart contracts. Non-Fungible Tokens (NFTs) based on the ERC-721 tokens are used to represent properties whereas fractional ownership is ensured through ERC-20. Also, smart contracts are developed for voting in tokenized property and migration of contracts.

Results & Discussion: The platform allows buying/selling and investing while eliminating intermediaries to reduce cost and time. ERC-721 tokens ensure unique property ownership and ERC-20 tokens enable fractional ownership and voting rights. The designed custom blockchain enhances compliance and privacy, aligning to legal frameworks of the country. Smart contracts tested on Remix and Ganache platforms are integrated with the custom blockchain to securely record validated transactions. However, the practical implementation is constrained with regulatory restrictions for blockchain, smart contracts, tokenization and cryptocurrency.

Conclusion: This blockchain based platform will provide a feasible and novel solution to the conventional real estate platforms enhancing its transparency, accessibility, and effectiveness. In the future, it could be improved by AI-based pricing, bidding, and integration with a real-world database and support wider applications in other sectors such as finance and governance.

Keywords: Blockchain, Non-fungible tokens, Smart contracts, Tokenization

A Review of Ultrasonic Viscosity Measurement: From Theory to Industry and Beyond

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Introduction: Viscosity indicates fluid's resistance to deformation and is a crucial parameter in material processing and flow dynamics. Traditional viscosity assessment often relies on mechanical interaction, which limits applicability in opaque or chemically reactive environments. In contrast, ultrasonic methods utilize acoustic wave behavior to evaluate fluid rheology in real time and without physical intrusion. Acoustic techniques measure how ultrasound interacts with fluid media to reveal viscosity-related properties. This non-invasive approach operates effectively in extreme or confined conditions, analyzing both Newtonian and non-Newtonian systems through changes in acoustic parameters.

Objectives: his article compiles key insights into ultrasonic viscosity quantification, covering foundational physics, measurement strategies, and signal interpretation. The novelty of this review lies in synthesizing diverse approaches, wave mechanics, sensing hardware, and industrial case studies, into a unified perspective that highlights not only what is known, but also what remains unresolved. Unlike earlier surveys, this review places particular emphasis on identifying cross-disciplinary links between acoustic theory, sensor design, and industrial scale deployment.

Methods & Analysis: The review covers how longitudinal, shear, and surface waves relate mathematically to viscosity, and examines common techniques such as pulse-echo, through-transmission, and resonant frequency systems. Advances in piezoelectric transducers, waveguide sensors, and modern signal processing are highlighted. Applications span petroleum, bioprocessing, and food industries, with examples of in-line sensor arrays for continuous monitoring and control.

Conclusion: Ultrasonic viscometry is evolving toward networked systems, adaptive analytics, and biomedical uses. This review maps current knowledge, highlights, unresolved issues, and points to future directions such as machine learning based interpretation, advanced waveguide materials, and standardized benchmarks. By summarizing both progress and challenges, it aims to drive innovation and practical adoption.

Keywords: Acoustic wave propagation, In-situ measurement, Piezoelectric transducers, Process monitoring, Ultrasonic viscometer

Body Metrics Evaluation Device

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Introduction: Body Metrics Evaluation Device (B-MED) is an all in one solution for fitness enthusiast to keep track of essential health parameters such as height, weight, blood oxygen level, heart rate and BMI. The device is made to be a fierce competition to high end Chinese counterparts with basic calibrations reducing the readings viability.

Objectives: B-MED will allow users to have access to their everyday health data over an ergonomic interface. The system guarantees precise measurements over the competitive models available on the market. Secondary objectives include reducing complexity in both manufacturing and assembly processes, enhancing UI and data privacy.

Methodology: State of the art Time-Of-Flight (TOF) sensors for enhanced distance measurements and differential pair of load cells over an external ADC and signal processing to counteract any balancing effects provides precise and accurate height, weight and BMI. MAX30100 module used to measure heart rate and SpO2 level is calibrated with clinically precise pulse-oximeter through linear approximation. The device itself comes with a synchronous switch mode power supply and custom battery monitoring system for reliability. Data initially stored locally on a microSD as a data logger, later sent to a secure database over wifi. The device has direct front end over a built-in display and a secure web-app for data visualization, trend analysis and user notifications

Results & Discussion: TOF sensors result in a 50% higher accuracy compared to ultrasound sensors. SpO2 and heart rate calibrations results around 10% and 5% variance reduction. With our modular design, we were able to lower the market price by 86% while also allowing future enhancements.

Conclusion: B-MED combines clinical grade accuracy with everyday usability, offering a reliable, affordable, and user-friendly solution for tracking key health metrics.

Keywords: Affordable health tracking, Cloud connectivity, Consumer health devices, Health monitoring platform, Sensor calibration

Evaluation of Void Spaces in Elliot Building Project as Natural Ventilation Channels: A Computational Study Using Computational Fluid Dynamics

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Introduction: Natural ventilation is a sustainable and low-cost alternative to mechanical systems in high-rise buildings, but it depends on the stack effect generated according to site-specific conditions and factors. This study investigates the feasibility of repurposing vertical void spaces in the Elliot Place residential project as passive ventilation channels, aiming to meet ASHRAE indoor air quality standards.

Objectives: To evaluate whether the void spaces in the Elliot Place project can function effectively as natural ventilation channels by ensuring upward airflow and meeting critical flow rate requirements for kitchens and toilets.

Methodology: The study employed theoretical calculations and Computational Fluid Dynamics (CFD) simulations using COMSOL Multiphysics. Five void geometries were analyzed under steady-state conditions using the $k - \omega$ turbulence model. Boundary conditions included pressure inlets, outlets, and wind velocity inputs based on site-specific data. Flow direction and velocity profiles were assessed against ASHRAE standards.

Results & Discussion: All test cases demonstrated consistent upward airflow, validating the stack effect as the primary driver. Velocity profiles at louver entries exceeded the critical threshold of 0.067 m/s, confirming compliance with ASHRAE ventilation requirements. Wind effects were supplementary, contributing marginally to pressure enhancement. The simulations aligned with theoretical predictions and prior research insights.

Conclusion: Void spaces in the Elliot Place project are suitable for natural ventilation. Optimized louver design and field validation are recommended to ensure performance consistency. This approach supports energy-efficient building design and improved indoor air quality.

Keywords: Airflow simulation, ASHRAE compliance, Natural ventilation, Stack effect, Void geometry

Development of a Digital Twin-Enabled Smart Home System for Integrated Monitoring, Control, and Prediction

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Introduction: Smart home technologies are advancing rapidly with the integration of Internet of Things (IoT) devices. However, most existing systems are siloed, focusing on specific functions such as energy monitoring or security, and often rely on proprietary technologies. This study aims to address these limitations by developing an integrated smart home system based on a Digital Twin (DT) framework to enable real-time monitoring, predictive control, and enhanced user interaction across multiple domains of a home environment.

Objectives: The key objectives of the project were to: (1) Improve energy efficiency using predictive control, (2) Enhance occupant comfort via personalized environmental settings, and (3) Improve safety by integrating facial recognition and fire detection within a unified DT system.

Methodology: A scaled two-story model house was constructed using plywood and acrylic. Various rooms were equipped with edge devices containing motion, flame, and air quality sensors. These devices communicated with a central Raspberry Pi 4 via the MQTT protocol. A web-based digital twin was developed using React and Node.js, featuring a live interactive 3D model and LSTM-based forecasting algorithms for proactive control and monitoring.

Results & Discussion: Testing showed high accuracy in facial recognition, fast fire detection, and robust synchronization between physical and virtual models. The system demonstrated measurable improvements in energy efficiency, comfort, and reliability. Its modular design allows future expansion with AI tools or cloud services.

Conclusion: This study presents a practical and scalable digital twin-driven approach to smart home development. It provides a foundation for future research in intelligent home automation with real-time feedback and predictive management, benefiting both users and the broader research community.

Keywords: Digital twin, Energy management, Predictive control, Real-time monitoring, Smart home

Evaluation of the Impacts of Improper Parking on Highway Capacity in Major Cities in Sri Lanka : A Case Study in Colombo City

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Introduction: Rapid urbanization and increased private vehicle ownership in Colombo, Sri Lanka's economic hub, have escalated demand for roadside parking. Inadequate infrastructure and enforcement have led to widespread improper parking, negatively impacting traffic flow and highway capacity.

Objectives: This study aims to examine current parking practices in Colombo, evaluate the effects of improper parking on road capacity, and recommend effective mitigation strategies.

Methodology: Data were collected from nine locations, covering 99 cases of improper parking. Surveys included road geometry, traffic volumes, and parking observations. Service flow rates were calculated using the Road Development Authority's (RDA) 1998 Highway Capacity Manual. Although dated, it remains the national standard. Comparisons were made between design and observed flow rates across A-class and B-class roads with four and six lanes.

Results & Discussion: Findings reveal a linear relationship between improper parking and the reduction in effective highway capacity. Even a minor encroachment of 0.5-1.0 m into the lane width resulted in a 10-24% decrease in service flow rate. The impact was more pronounced on A-class roads and during peak traffic hours, where lane obstructions significantly affected flow efficiency. These results highlight how seemingly minor parking violations can lead to substantial disruptions in urban traffic performance.

Conclusion: Improper parking significantly reduces road capacity in Colombo. Enforcing parking regulations, implementing smart parking systems, and optimizing roadside space are recommended to improve urban mobility and traffic safety.

Keywords: Capacity reduction, Highway capacity, Improper parking, Road width, Urban traffic

Study on the Impact of Rail Vibration on Slope Failures

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Introduction: Slope instability poses serious geotechnical hazards to railways, particularly in mountainous topography like Sri Lanka's upcountry railway. Rail-induced vibrations can cause or increase slope failures, which result in serious operational, safety, and economic hazards. To maintain rail safety and the sustainability of the infrastructure, it is essential to understand how train dynamics and slope behavior interact.

Objectives: This study aims to assess the influence of different soil properties and groundwater conditions on slope stability, evaluate the role of slope geometry in failure risk, and investigate the impact of rail load amplitude and maintenance level on the Factor of Safety (FoS) under dynamic conditions.

Methodology: A numerical modeling approach using Slope/W Limit Equilibrium Method (LEM) was employed. The study simulated various train speeds, maintenance levels, slope angles, soil properties, slope boundary conditions, and water table depths. Model validation was conducted against existing research benchmarks to ensure accuracy.

Results & Discussion: For static conditions, the dynamic FoS continued to decline steadily, whereas failure risk was enhanced by adverse track conditions and high-speed trains. Instability was indicated by FoS values < 0.85 at slope angles of 55° and speeds > 60 km/h. Important sensitivity parameters were identified, including groundwater depth, internal friction angle, and cohesiveness of soil. For that, seven empirical formulas were formulated to create a link between these parameters and FoS under varying conditions.

Conclusion: In critical terrain, vibration due to railways significantly weakens the stability of slopes. Real-time monitoring, grading of slopes, reinforcement of drainage, and maintenance with optimal care are necessary preventive interventions to be performed. The current paper proposes the identification of further studies under shifting climatic conditions and provides useful inputs for railway design and operation.

Keywords: Factor of Safety, Geotechnical modeling, Rail vibration, Slope stability, Slope/w

A Comprehensive Analysis of Factors Affecting Slope Stability

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Introduction: Slope instability poses a significant hazard in tropical countries like Sri Lanka, threatening communities and infrastructure.

Objectives: Analyze the effects of soil cohesion, friction angle, ground water table, slope angle and surcharge load on slope stabilization through examining the variations of the Factor of Safety (FoS).

Methodology: A model slope was developed through SLOPE/W software. Limited Equilibrium Method (LEM) employed using Spencer method as the analysis type. Parameter data were collected by referring related past literature. Data values are realistic, commonly used in slope design and provide good benchmarking for comparing sensitivity. They provide 1.085 initial FoS value for the model slope. Analysis is done for each parameter; soil cohesion, friction angle, ground water table, slope angle and surcharge load separately while other parameter values remain constant. Finally, percentage values of the parameters in regard to the effect on FoS were determined from the results of the stability analysis.

Results & Discussion: The impact of analyzed factors on slope FoS that cohesion 18.62%, friction angle 13.56%, ground water table 63.45%, slope angle 3.48% and surcharge load 0.89%. These analyses also apply to the past literature soil property values, and it indicate the mean values are in agreement with the research analysis results.

Conclusion: This research quantifies the sensitivity of analyzed geotechnical parameters which affecting slope stability, unlike traditional qualitative studies. It provides engineers with quantitative criteria to utilize in making decisions to enhance slope reliability and cost-effectiveness. It is very useful for mitigating landslide risks in local slope areas. The study can be improved by validating results using Finite Element Method (FEM) and combining outputs with Geographic Information Systems (GIS) for hazard mapping.

Keywords: Factor of Safety, Friction angle, Ground water table, Limit equilibrium method, Slope angle

Investigation of the Impact of Sugarcane Bagasse Ash on Low-Grade Concrete Properties

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Introduction: The possibility of Sugarcane Bagasse Ash (SCBA), an agricultural byproduct of Sri Lanka's sugar industry, as a sustainable partial substitute for cement in concrete is examined in this study.

Objectives: The study assesses how SCBA affects the physical and mechanical properties of low – grade concrete and find out the optimum cement replacement percentage (by weight) of SCBA.

Methodology: SCBA samples were added to grade 20 concrete mixtures at weight percentage replacement levels of 0%, 5%, 10%, 15%, and 20%. Two specimens for each percentage were cast for each test for a total of 20 cubes and 10 cylinders. SCBA samples were obtained from Lanka Sugar Company Limited – Pelwatte. Compressive strength test (BS EN 12390:3), split tensile strength test (ASTM C496/C496M), slump test (ASTM C143), density test (BS EN 12390:7) and water absorption test (BS 1881-122), were done by following Standard methodologies.

Results & Discussion: According to the results, in comparison to the control mix, all SCBA replacement levels resulted in decreases in compressive and split tensile strength, with significant strength losses seen at replacement levels of 10% - 20%.5% SCBA improved workability (slump increase of 7.5%) and reduced strength the least of all the mixtures. Densities were larger than the control mix for both the 5% and 10% replacements; however, with 10% replacement, strength loss was more noticeable, and water absorption rose, suggesting lower durability.

Conclusion: Despite these limitations, the study supports the possibility of using SCBA as a partial cement replacement at the ideal percentage (5%), because it reduced strength loss while improving workability and keeping density within a reasonable range.

Keywords: Cement replacement, Compressive strength, Split tensile strength, Sugarcane Bagasse Ash, Sustainable concrete

Web Crippling Behavior of Lipped Channel Sections using Stiffener Plates

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Introduction: Cold-Formed Steel (CFS) sections possess high strength-to-weight ratios but are prone to web crippling if subjected to localized loads. Few research efforts exist on the reinforcement of such sections with practical methods. The current study experimentally investigates the behavior of high-strength CFS lipped channel sections reinforced using stiffener plates under Interior Two-Flange (ITF) loading conditions.

Objectives: Carry out experimental tests to investigate the web crippling behaviour under ITF loading method. Understand the fixing methods of stiffener plates to the channel web.

Methodology: Fifteen cold-formed steel-lipped channel sections were tested, eight with 100 mm webs and seven with 150 mm webs. L-shaped stiffeners were applied in inward and outward orientations with spacings of 100 mm, 140 mm, 160 mm, and 220 mm. 5 mm gap between stiffener and flange was left unwelded for 100 mm specimens and welded for 150 mm specimens. All were tested under ITF loading using a 1000 kN instron testing machine at 1 mm/min until failure. Load displacement data and failure modes were recorded. Material properties were determined via tensile coupon tests.

Results & Discussion: Stiffened test specimens possessed two to three times greater web crippling strength than unstiffened controls. The maximum load (38.95 kN) was observed for the 150 mm outward-stiffened test specimen with no spacing. Outward stiffeners were better than inward stiffeners on all instances. Smaller stiffener spacing provided greater load-carrying capacity, with a noticeable decrease in performance when the spacings enlarged.

Conclusion: These findings contribute valuable experimental evidence for the advancement of cold-formed steel design practices and offer potential recommendations for future updates to structural design codes such as AISI S909.

Keywords: Interior Two-Flange loading, Lipped channel section, Stiffener plate, Web crippling

Analysis of Ground Movements Using InSAR: A Case Study for Badulla District, Sri Lanka.

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Introduction: This study maps landslide susceptibility in the Badulla District, Sri Lanka, using slope, elevation, rainfall, and InSAR-derived ground deformation data.

Objectives: Map the regions undergoing ground deformations in the Badulla district using InSAR techniques. Measuring the displacement of the ground movements within the landslide areas. Investigate the relationship between InSAR data and other geospatial information. Compare the InSAR-detected ground movement data with current landslide records and geological data to evaluate the accuracy.

Methodology: Sentinel-1 SAR data 2015–2019 were pre-processed using SNAP (orbit correction, thermal noise removal, calibration, debursting, merging, terrain correction). Interferometric analysis produced backscatter change maps, which were combined with slope and rainfall data in ArcGIS 10.8 to generate hazard maps. Model calibration was conducted by comparing predicted high-risk zones with the NBRO landslide inventory, and accuracy was evaluated using a confusion matrix.

Results & Discussion: Backscatter drops ($\leq -2\,\text{dB}$) identified unstable slopes, with 12% of the district classified as high-risk. Haldummulla and Passara showed the highest instability. Landslides occurred mainly on steep slopes (40°–80°) and elevations above 1400 masl. Temporal correlations between rainfall and landslides highlighted a lag effect. Human activities, such as road construction and deforestation, contributed to landslides in areas otherwise classified as low-risk.

Conclusion: SAR proved effective in detecting slope failures two to three years before occurrence. The integration of slope, rainfall, and backscatter data enhanced hazard prediction, while validation with NBRO data confirmed reasonable model reliability. However, the absence of detailed soil and lithological data remains a limitation, underscoring the need for higher-resolution datasets and dynamic land-use integration in future studies.

Keywords: Gound deformation, InSAR, Landslide susceptibility, Sentinel-1 SAR

Quantifying Coastal Sediment Dynamics Using Open-Source Data

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Introduction: This study examines shoreline changes from Negombo Doowa Beach to Uswetakeiyawa Beach during 2015–2025 in Sri Lanka. Reports indicate severe erosion in this area . However, long-term, zone-specific studies remain limited, and this research fills that gap.

Objectives: To identify the coastal areas severely affected by erosion, analyzing and comparing the underlying causes of erosion in these areas, and proposing effective solutions to mitigate its impact.

Methodology: Using the GIS approach, satellite images from USGS Earth Explorer were used, and an analysis of past shorelines was done with the use of DSAS v.6.0. To find long-term patterns, 411 transects along the coast were classified into four zones and evaluated with WLR (Weighted Linear Regression). The seasonal effects on shorelines were analyzed in this study, which is classified into four zones.

Results & Discussion: According to the results, accretion was observed in 246 transects (59.85%), yet erosion was seen in 161 (39.17%) of the area studied. While there was more accretion in Zone 2, Zone 4 suffered the most from erosion. The shoreline shifted up an average of +0.279 m every year. Accretion was higher in the Southwest monsoon than in the Northeast monsoon. A noticeable erosion percentage was observed in Zones 3 and Zone 4 in both monsoons. In both Zone 3 and Zone 4, severe erosion during both monsoons may have been caused by intense wave activity, poor planning in coastal buildings, and sediment shortages.

Conclusion: Beach nourishment initiatives, such as the 2012 Uswetakeiyawa project, are recommended for eroded areas, along with continuous monitoring using GPS to track shoreline changes.

Keywords: Accretion, Coastal erosion, Monsoon, Shoreline change

Potential to Replace Waste Plastic as Fine Aggregates in Concrete in Terms of Compressive Strength

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Introduction: Plastic waste poses a severe environmental challenge, and recycling it in construction offers a sustainable solution. Sand, widely used as a fine aggregate in concrete, is becoming scarce and costly, particularly in countries like Sri Lanka. This study investigates the feasibility of using Polyethylene Terephthalate (PET) as plastic waste to partially replace fine aggregate in concrete.

Objectives: The study aims to compare natural sand and recycled plastic fine aggregates in concrete, assess the effect of PET replacement on compressive strength, and determine the maximum replacement percentage that maintains satisfactory structural performance.

Methodology: An M25 concrete mix was prepared using Ordinary Portland Cement, river sand, crushed stone, PET as plastic waste (4–12% replacement by weight), and water. PET was washed, crushed below 4.75 mm, and incorporated into the mix. Workability was assessed through slump tests, while compressive strength was tested at 7 and 28 days.

Results & Discussion: Workability decreased as PET content increased; slump decreased from 173 mm (0% PET) to 85 mm (12% PET). After decreasing from 27.38 MPa (control) to 23.93 MPa (6% PET), compressive strength likewise decreased. Strength readings approached or dropped below the necessary 23 MPa after 6% replacement. As a result, PET, a waste plastic, can substitute fine aggregate up to 6% without affecting performance.

Conclusion: PET as plastic waste offers potential as a sustainable fine aggregate substitute in concrete. While workability and strength decrease with higher PET content, replacements up to 6% are viable for non-structural applications. Further research should address reinforced applications, particle characteristics, and additional mechanical properties.

Keywords: Compressive strength, Slump test, Sustainable concrete, Workability

Potential to Replace Waste Plastic as Fine Aggregates in Terms of Flexural Strength

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Introduction: The growing accumulation of plastic waste poses serious environmental challenges. Recycling and reuse strategies are essential to reduce its impact. One promising method is the partial replacement of natural sand with recycled plastic as fine aggregates in concrete.

Objectives: This study aims to compare Recycled Fine Aggregates (RFA) from Polyethylene Terephthalate (PET) waste with natural sand, to investigate their effect on the flexural of concrete, and to identify an optimum replacement level that ensures acceptable performance.

Methodology: This research evaluates the flexural strength of concrete with varying percentage of plastic waste as fine aggregate replacement. Beam specimens (150 × 150 × 750 mm) were tested for flexural strength. It performs test to study the size, shape and distribution of plastic particles and their effect on concrete properties. All specimens were cured and tested at 7 days and 28 days. Conventional concrete mixes were used as the control for comparison.

Results & Discussion: The results showed that the specimens containing partial substitution ratios ranging from 0% to 12% performance. At 28 days, flexural strength dropped by 35% compared to conventional concrete. The highest strength was recorded 3.1N/mm2 at 28days. Mixes containing 0% to 6% PET replacement reached minimum required flexural strength.

Conclusion: This research contributes to the advancement of eco-friendly construction materials by promoting the reuse of plastic waste in structural applications. If properly optimized, plastic modified concrete has the potential to reduce plastic pollution while addressing the construction industry's demand for sustainable resources. The study concludes with the recommendations for further research on improving the durability, boding characteristics and large scale implementation of plastic based concrete.

Keywords: Polyethylene Terephthalate, Recycle Fine Aggregates, Sustainability

Investigation of Durability Properties of Autoclaved Aerated Concrete

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Introduction: Autoclaved Aerated Concrete (AAC) has gained attention as a sustainable, lightweight alternative to conventional concrete. While its mechanical properties are well-studied, limited research exists on long-term durability under tropical conditions where high evaporation rates (ACI 305) may influence performance. This study investigates the water absorption and drying shrinkage characteristics of AAC compared to conventional Portland Pozzolana Cement (PPC) blocks under controlled laboratory conditions.

Objectives: To conduct a comprehensive literature review on the durability properties of AAC. To evaluate and compare the water absorption and drying shrinkage of AAC and PPC blocks, with PPC as the benchmark.

Methodology: Three AAC block samples and three PPC block samples, each 100 mm × 100 mm × 100 mm, were obtained and tested in accordance with SLS 855 Part 1 and Part 2 standards. Uniform testing procedures and identical environmental conditions were maintained to ensure accuracy and reproducibility.

Results & Discussion: AAC blocks recorded significantly higher mean water absorption (57%–59%) than PPC blocks (11%) due to their porous microstructure. However, AAC exhibited lower drying shrinkage (0.010%–0.019%) compared to PPC (0.038%–0.045%), indicating better dimensional stability. PPC's intermediate performance stems from its denser matrix, limiting water ingress but increasing shrinkage-induced cracking risk. These findings highlight a trade-off between moisture susceptibility and shrinkage resistance, crucial for material selection in tropical climates.

Conclusion: Despite higher water absorption, AAC's superior dimensional stability and reduced cracking risk make it suitable for sustainable construction. Protective coatings or supplementary cementitious materials (e.g., fly ash, slag) can mitigate moisture concerns, enhancing AAC's suitability for lightweight, durable applications in tropical environments.

Keywords: Autoclaved aerated concrete, Dimensional stability, Drying shrinkage, Sustainable construction, Water absorption

Fostering Sustainable Agriculture in Kilinochchi, Sri Lanka, through Nature based Solutions

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Introduction: The sustenance and continuum of sustainable agricultural practices support the UN Agenda 2030 and fosters an ecosystem furthering away from socioeconomic vulnerability. This study focuses on the Iranamadu Reservoir, a pertinent water source for Kilinochchi, Sri Lanka – a region which is deeply reliant on agriculture. Rising water demands require assessing the reservoir capacity for the next 50 years. Additionally, salinity concerns and its impact on crop productivity in the catchment area highlight the importance of examining land use and vegetation sustainability under shifting climatic conditions.

Objectives: To quantify the salinity presence in the region on the catchment area identified via the Iranamadu reservoir in Kilinochchi, Sri Lanka. Therein, to ascertain innovative solutions focusing on precise crop production, reverse osmosis systems, remote sensing NbS in irrigation practices.

Methodology: Geographic Information System software was used to perform delineation procedures in the catchment area stipulated by the Iranamadu reservoir. Two types of salinity indices were found to comprehend the presence of salinity using Landsat 8 imagery. This was brought into comparison with the land use classification map done on the catchment area. The kappa coefficient was used for the accuracy assessment.

Results & Discussion: The accuracy assessment of the land use classification brought about a kappa coefficient of 0.6, translating to a substantial agreement with the ground truth. Hence, whilst medium salinity levels are cited, the salinity presence is seen in some areas of fallow or vegetation land areas, amounting to 8.6% and 23.4% of catchment area, respectively.

Conclusion: Dense vegetation amounts to 41.7% of the catchment area, where Nature based Solutions (NbS) like agroforestry can be adopted. This will enhance soil structure, improve water retention, and reduce runoff and salinity risks. Incorporating salinity-tolerant crops and precision agriculture to enhance land use in saline-affected regions, supplemented by solar-powered desalination units will foster sustainable irrigation.

Keywords: Geographic Information System, Irrigation, Land use classification, Nature based solutions, Salinity

Improvement of Geotechnical Properties of Cricket Pitches in Sri Lanka Using Expansive Soil from Hambanthota

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Introduction: Sri Lankan cricket pitches are typically characterized by their slow pace, low bounce and the rapid deterioration. Therefore, the local players often fail on the fast pitches due to the lack of experience of similar pitches in the home country.

Objectives: To determine the geotechnical characteristics of existing pitches and evaluate the potential of Hambantota expansive soil to improve the performance of local cricket pitches.

Methodology: A series of laboratory tests were conducted on the two sample samples which were collected from the Khettarama Stadium and the Hambantota. Swell potential of the samples was determined through Shrink-Swell Index (SSI), Free Swell Index (FSI), and swell pressure tests while strength characteristics were determined through Unconfined Compressive Strength (UCS) test using triaxial apparatus, conducted over three consecutive days exposing to actual environmental conditions. Ultimately, bounce test and crack pattern analysis were performed.

Results & Discussion: Hambantota soil exhibited higher clay content (36%) and low organic content (3.24%), compared to Khettarama sample which has 28% clay and 9.61% organic matter. The expansive nature of the Hambanthota soil is confirmed with SSI of 1.77%, FSI of 25%, and a swell pressure of 25 kPa. UCS test and MDD results showed the higher strength of the Hamabanthota soil which confirmed by the very fine hair cracks of model pitches compared to extensive cracks about 3 mm in the Khettarama model pitch. The Coefficient of Restitution (COR) for the Hambantota pitch model was 0.589, which is significantly higher than the COR (0.543) for the existing soil.

Conclusion: Existing local pitches underperform due to inappropriate geotechnical properties. Hambantota soil demonstrates promising potential, offering improved bounce and stability, making it a viable alternative for enhancing cricket pitch quality.

Keywords: Bounce, Cricket pitch, Expansive soil, Hambantota, Pace

Comparison of Indoor Thermal Condition of Different Construction Material used in Sri Lanka

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Introduction: This study examines the indoor thermal comfort of three different block wall materials that are widely used in Sri Lanka. The study used thermal performance of Autoclaved Aerated Concrete (AAC) blocks, Cement Stabilized Earth Blocks (CSEB), and Cement blocks to evaluate most effective combination with building orientation and Wall Window Ratio (WWR) to improve the thermal comfort.

Objectives: The study aims to analyze the impact of wall material on building orientation (north, east, south and west) and WWR (20% and 30%) and objective is to evaluate lowest indoor temperature that we can achieve by considering those parameters under the Sri Lankan climate condition.

Methodology: Single story house model consist with total area of 57.64 m^2 and 200 mm thickness wall was used. Simulation was done by using Design Builder V 7.0.2.006 software. Key thermal characteristics such as the operating temperature, radiant temperature, and indoor air temperature were examined in the course of the research. The air temperature and the operational temperature. Since they most accurately depict how people actually feel heat within a structure, these are acknowledged as crucial indicators of thermal comfort in international construction standards like ASHRAE 55.

Results & Discussion: AAC blocks perform better in thermal insulation than cement and CSEB blocks, lowering interior temperatures and minimizing requirements for mechanical cooling systems because of low thermal conductivity characteristic of AAC block reduce the heat gain through the wall from outside and keep indoor temperature low more than the other material. West-facing orientations receive a lesser amount of direct sunlight, they show the lowest internal temperatures. Additionally, raising WWR from 20% to 30% caused a minor increase in indoor temperatures for all materials, demonstrating how window size affects heat gain.

Conclusion: Residential structures can improve indoor thermal comfort while minimizing energy consumption by choosing suitable wall materials and improving passive design characteristics like orientation and WWR.

Keywords: Building orientation, Energy efficient, Indoor thermal comfort, Window Wall Ratio

Improvement of Reclaimed Land by Dynamic Compaction Method

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Introduction: Dynamic Compaction (DC) is an effective ground improvement method for land reclamation. The fundamental improvement mechanism in loose sandy soil deposits, especially the depth and extension of improvement, varies with the different soil characteristics. This study presents a laboratory-scale 2D physical model that simulates the response of loose sandy soil using GeoPIV-RG software and high-speed photography.

Objectives: Capturing the real-time densification mechanism and studying the effect of impact energy and initial void ratio on DC.

Methodology: A 1-g small-scale physical model was developed, consisting of a glass-fronted sand container (750 mm thick sand layer), a 5 kg tamper with drop heights up to 200 mm, and instrumentation. The poorly graded sand used was compacted at different initial void ratios (35%–65%). Two pressure sensors (at 100 mm and 200 mm depths) monitored stress variations. A high-speed camera positioned perpendicular to the glass face captured sectional views through a 12 mm glass wall. Images were analyzed using GeoPIV-RG to identify localized deformation zones. Compaction bands, defined as narrow zones of concentrated strain, were tracked as they formed and propagated under successive impacts.

Results & Discussion: The results show that densification initiates with the propagation of compaction bands, and those compaction bands stabilized after 5-6 drops. The depth of pounder penetration is limited after 12-15 drops because the top layer of loosened soil due to tamping fills again the carter when the hammer rises. When the impact energy rises, the initial crater depth increases, while the depth of penetration decreases with increasing relative density.

Conclusion: The study concludes that the DC happens with the propagation of compaction bands, which stabilized after 5-6 drops, and the depth of pounder penetration varies with initial relative density and impact energy.

Keywords: Depth of improvement, Dynamic Compaction, GeoPIV-RG, Real-time densification, Strain localization

Applicability of Microwave Oven for Rapid Determination of Moisture Content in Compacted Soil

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Introduction: In typical field and laboratory inspections, a convection oven is used to determine the moisture content of soils. However, conventional ovens require approximately 24 hours to dry soil samples and produce results. This extended drying time can delay construction progress and lead to additional costs for contractors, as subsequent work at the site cannot proceed without the test results.

Objectives: The objective of this study was to evaluate the accuracy of microwave ovens in determining the moisture content of granular soils, and to compare these results with those obtained using a standard convection oven.

Methods & Analysis: Soil samples used in this test were taken after Proctor compaction tests were done for 5%, 10%, 15% and 20% moisture levels. Results from the standard oven were treated as the benchmark for comparison, and the time required to reach a constant weight using the microwave oven was also recorded. The soil samples used in this study were granular (coarse-grained) soils collected from the premises of CINEC University. Both a standard oven and a microwave oven were used for testing. Microwave testing was conducted at three power levels: 440W, 620W, and 800W. Pilot tests were also carried out at 100W and 220W, but these power levels were excluded from the main study due to their long drying times. Total of 48 soil samples were tested, 24 using the standard oven and 24 using the microwave oven. After the tests, a statistical comparison using paired T-tests was conducted to evaluate the consistency between the two methods.

Conclusion: The findings revealed that a microwave power level of 440W provided the most accurate and reliable results in comparison to the standard oven. It was also noted that using higher power levels, such as 800W, is unsafe as the soil samples tended to burn and also compromising the integrity of the results.

Keywords: Granular soil, Microwave drying, Moisture content

Building Research and Innovation Ecosystem with Transnational Education in System Health Monitoring Technology

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Introduction: The global shift to sustainable energy and transportation demands innovation in both technology and human capital. System Health Monitoring (SHM) provides critical solutions, but advancing the field requires education that develops interdisciplinary problem-solving skills and fosters international research collaboration.

Objectives: This paper presents an initiative integrating Transnational Education (TNE) with SHM research to build innovation capacity and workforce development. Through cross-border university–industry partnerships, the program combines technical training, collaborative research, and entrepreneurial skills, emphasizing knowledge co-creation and technology transfer.

Methodology: The Battery Health Monitoring (BHM) project exemplifies this approach. Delivered at Institut Teknologi DEL in Indonesia by the author, it embeds evidence-based pedagogy into engineering curricula. Students gain expertise through EV battery prototyping and simulation, while staff advance in pedagogy and EV technologies. The project enhanced local innovation capacity in sustainable mobility, demonstrating integration of education with applied research. Parallel work addresses industrial demand for corrosion monitoring, with the market projected to grow from USD 2.8B in 2024 to 3.7B by 2026. Offshore wind energy faces corrosion failures causing up to 75% of structural issues.

Results & Discussion: A proof-of-concept wireless sensor network trial on a UK offshore wind turbine successfully predicted structural lifespan using corrosion characteristics. Electrochemical measurements; ;rates Open Circuit Potential (OCP), the Electrochemical Impedance Spectroscopy (EIS), the Zero Resistance Ammeter (ZRA), the Linear Polarization Resistance (LPR), and the Electrochemical Noise (EN). and structural lifespan. End users can assess and benchmark the integrity of the structure influenced by corrosion using this data base. Ongoing research extends monitoring to rebar concrete in simulated marine environments. TNE broadens application, accelerates innovation, and engages stakeholders in renewable energy preservation.

Conclusion: Preliminary outcomes highlight the value of embedding SHM research within TNE: students gain multidisciplinary skills, institutions strengthen global collaboration, and industry benefits from faster innovation pipelines. This framework demonstrates how education and research can align to build sustainable, resilient innovation ecosystems.

Keywords: Battery health monitoring, Corrosion sensors, Offshore wind energy, System Health Monitoring, Transnational Education

Faculty of Computing

Extension of Non-Obtrusive Imposter Detection During Online Tests to Detect Fraudulent Acts other than Impersonation

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Introduction: Institutions are facing a major challenge when conducting online assessments due to the tendency of cheating candidates to engage in fraudulent acts. Impersonation is the most widespread. Other fraudulent acts are tapping, collaboration and lookup. Institutions must be able to detect all fraudulent acts to preserve the integrity of their online testing process.

Objectives: To examine the possible extension of an authentication system that uses 'free text keystroke dynamics', developed and tested by the authors for non-obtrusive imposter detection during online tests, to detect other fraudulent acts.

Methodology: Two online tests were designed to simulate the acts of collaboration and lookup. Volunteers were deployed to take the tests roleplaying as candidates. Their keystroke data were captured. Simulations were played back offline while being authenticated using the imposter detection system. Standard performance metrics were computed.

Results & Discussion: The imposter detection system tested previously had an FAR of 33.0%, T2FD of 0.52 minutes, and FAWI of 3.00 minutes. When detecting collaboration, the corresponding figures were 40.1%, 1.84 minutes, and 3.38 minutes respectively. When detecting lookup, they were 48.3%, 0.58 minutes, and 2.77 minutes respectively. This indicates that the imposter detection system can detect collaboration and lookup as well, but with lower accuracy. To detect all fraudulent acts, it needs finetuning.

Conclusion: The lower accuracy is due to the classifiers used for detection having learnt only from training data derived from scenarios of impersonation. To make the classifiers equally sensitive to other fraudulent acts, they need to be further trained on data derived from scenarios of such acts. This is suggested as future work. An online test system with robust, non-obtrusive fraud detection capability would strengthen the confidence of genuine candidates on the system. It would also provide the society a merit based education system.

Keywords: Continuous authentication, Keystroke dynamics, Online tests

Automated Fine Management for Digital Traffic Enforcement: A Case Study of Sri Lanka Police

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Introduction: The existing manual traffic violation detection and traffic fine handling system has several drawbacks, such as time labor-intensive and prone to human errors. Delays associated with fine processing and mandatory physical visits to the police station have intensified the issues. Real-time Communication between police officers stationed at different checkpoints remains limited in the current system. Legal action is delayed, hence damaging public confidence in the system.

Objectives: This project aims to address the limitations of the existing system by creating an automated traffic fine management system that facilitates an efficient and trustworthy solution by streamlining the key process between traffic rule violators and traffic police officers.

Methodology: The MERN (MongoDB, Express, React, and Node.js) stack was utilized in the development of the system, which has role-based access for security and a fuzzy logic search for adaptable queries. Drivers can now pay with a card after entering a fine ID and verifying their information with the integration of Stripe Checkout. The database's fine status is automatically updated upon successful payments, guaranteeing immediate confirmation and preventing delays.

Results & Discussion: The automated key processes, such as the fine payment and reminder module, ensure that the public adheres to the fine payment process. The violator can settle the fine directly through an integrated online payment gateway upon receipt of the violator's ticket, thereby reducing procedural delays. An internal secure messaging service for the nearest police officers ensures synchronous communication between users.

Conclusion: The proposed robust system aids efficient processing of traffic violations, minimizes human intervention while ensuring a secure and convenient digital solution in traffic violation law enforcement. Mobile responsiveness and usability of the platform enable ease of access across devices.

Keywords: Automation, Fuzzy logic, Secure communication, Traffic fine management, Traffic violation

Enhancing Efficiency and Reliability in the Transportation System of Sri Lanka

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Introduction: The traditional driver hiring available in Sri Lanka operates completely manually, leading to several drawbacks for both passengers and drivers in the business. It is an unreliable and slow system due to the unavailability of real-time communication, no secure payments, and lack of transparency in operations. Effective feedback and independent driver hiring are not supported by the current manual platforms. An automated system is developed to link vehicle owners with vetted drivers and provides safe payments, automatic pricing, and real-time communications.

Objectives: The solution aims to develop a comprehensive online platform that efficiently connects vehicle owners with qualified drivers, streamlining the hiring process and enhancing transparency and reliability.

Methodology: After completion of requirements gathering, the system was designed using flow charts, use cases, sequence and ER diagrams. The Waterfall Model was adopted to develop the application with the technology stack as Node.js/Express for backend functionalities and chat, ReactJS for the frontend. Stripe facilitates payments, JWT provides secure access, GPS to track real-time locations, and MongoDB manages data in the system. The platform was thoroughly tested for security and dependability.

Results & Discussion: The developed system effectively simplifies the process of hiring a driver with advanced features such as efficient and independent driver recruitment, automated fare calculation, and accountable, secure payments compared to manual systems. Service reliability is enhanced by role-based access controls and real-time communication. Although there are still issues with uptake and scalability, preliminary user data indicate increased satisfaction. This demonstrates the system's uniqueness in offering a technologically advanced, local solution for Sri Lankan driver recruitment.

Conclusion: The created system provides a transparent, effective, and safe platform that is adapted to local requirements, modernizing driver hiring in Sri Lanka. It provides quantifiable time, cost, and reliability benefits, laying the groundwork for broader adoption.

Keywords: Automated pricing, Driver hiring, Real-time messaging, Secure payment, Sri Lanka transportation

Introducing a Smart Apparel Management Web Application Combining Real-Time Production Tracking and Customizable T-Shirt Ordering Platform

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Introduction: The apparel industry faces persistent inefficiencies, delays, and material waste due to manual processes. To address these challenges, a Smart Apparel Management Web Application was developed. The system integrates real-time production tracking, AI-driven fabric cutting optimization, and an interactive T-shirt customization platform. By combining these modules, the application minimizes forecasting errors, enhances design accuracy, and improves workflow efficiency for small- and medium-scale garment factories.

Objectives: The project aims to modernize apparel manufacturing through a scalable and cost-effective web-based system. Its objectives are workflow automation to reduce human error, fabric optimization through AI-based cutting algorithms, real-time production monitoring, customer engagement via interactive T-shirt customization, and improved inventory management.

Methodology: Requirements were collected through structured interviews with managers, operators, and marketing staff, supplemented by workflow observations. The modular system architecture was implemented using React.js, Tailwind, Node.js, and MongoDB, with communication handled through an integrated API layer. AI-driven cutting optimization was achieved using the Greedy placement algorithm.

Results & Discussion: The system delivers real-time dashboards for production and inventory, an intuitive T-shirt customization interface, and AI-based cutting optimization, achieving a 10–15% reduction in fabric waste. Pilot testing confirmed reduced operational delays, improved production accuracy, and high usability for staff. The integration of AI and real-time monitoring demonstrated clear cost savings and productivity gains for small to medium-sized manufacturers.

Conclusion: The Smart Apparel Management System enhances manufacturing efficiency, reduces material loss, and engages customers through digital customization. It demonstrates how AI and modular web technologies can revolutionize apparel production in emerging markets by providing a practical, user-friendly, and economically viable solution.

Keywords: AI, Apparel, Customization, Optimization, Tracking

Smart Grid-Based AI Monitoring System for Enhancing Power Grid Stability in Sri Lanka

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Introduction: Fault Detection and Isolation (FDI) is a critical function in smart grids that ensure grid stability, minimize outages, and improve electricity reliability. Traditional SCADA-based systems in Sri Lanka provide limited real-time analytics and predictive capabilities, making them insufficient for modern grid demands. This study proposes an AI-driven solution to enhance FDI processes and strengthen national grid performance.

Objectives: The main objective is to design and implement an intelligent FDI framework using Artificial Intelligence (AI) and Internet of Things (IoT) technologies. The system aims to detect, classify, localize, and predict faults in real time, enabling faster responses and proactive grid management.

Methodology: IoT sensors were deployed across transmission and distribution networks to collect real-time data, including voltage, current, and frequency. Machine learning models trained on historical fault datasets were used to identify anomalies and classify fault types. A simulation environment was developed to evaluate system performance under diverse fault scenarios.

Results & Discussion: The AI model achieved a fault detection and classification accuracy of over 92%. Faults were localized within milliseconds using PMU time-series data. Predictive analytics successfully identified early equipment failure risks, while real-time isolation enabled self-healing capabilities, improving grid resilience and operational efficiency.

Conclusion: AI-enabled FDI significantly enhances fault management in power systems. Future work will focus on field deployment, integration with CEB infrastructure, and scaling the framework to accommodate renewable energy integration.

Keywords: AI fault detection, Machine learning, Power systems, Smart grid

AI-Powered Micro-Level Dengue Outbreak Prediction and Early Warning System Using Geospatial and Environmental Data – Denguard

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Introduction: Dengue fever is a significant public health problem in most tropical and subtropical nations, including Sri Lanka. Outbreaks are typically detected by conventional surveillance systems after they have occurred, rendering preventive measures impossible. This project aims to bridge this gap by developing an AI-powered system capable of predicting dengue outbreaks before they happen using real-time environmental and public health data.

Objectives: The central objective is to create an early and anticipatory warning system of dengue outbreaks at a micro-level (street or village) based on artificial intelligence and geospatial data. The system is designed to assist public health personnel as well as local communities in taking anticipatory measures to reduce the spread of dengue.

Methodology: The system collects data such as weather patterns, population, past dengue cases, and waste management reports. AI models such as LSTM and Random Forest are employed for time-series forecasting and classification. A web and mobile app, developed with React and Flutter, displays risk zones as GIS-based heatmaps. Users can upload images of suspected breeding spots, which are processed with computer vision models such as YOLOv8. SMS and push notifications generate alerts and updates.

Results & Discussion: The model was able to forecast high-risk areas up to 3 days in advance of actual case surges, achieving a prediction accuracy of 87% with a precision of 82% and recall of 85%. Field validation was enhanced by community image uploads, and micro-level heatmaps enabled targeted spraying and public awareness campaigns.

Conclusion: The system demonstrates the potential of AI to address real-world public health challenges by enabling early detection of outbreaks and fostering public engagement. Future work will focus on incorporating IoT data, further improving model performance, and expanding coverage.

Keywords: Artificial Intelligence, Dengue prediction, Geospatial analysis, Machine learning

An AI-Powered Mobile Application for Simplified Blood Report Analysis and Personalized Health Monitoring – HealthLens

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Introduction: Healthcare has evolved a great deal in recent years, yet reading medical test reports, especially blood reports, still remains a challenge for the majority. Misinterpretation can lead to unnecessary stress or delayed treatment. To address this gap, we are developing an AI-enabled mobile app that simplifies blood report interpretation and encourages proactive health management. Beyond individual patients and clinicians, this solution is also designed to benefit healthcare organizations, clinics, and community health services seeking scalable patient monitoring and communication tools.

Objectives: The primary objective is to develop an AI-powered mobile app that interprets blood reports in a simple, understandable way by using AI and OCR to extract parameters, provide multilingual audio explanations, track health history, send emergency alerts, integrate with wearables, and enable secure doctor sharing with personalized recommendations.

Methodology: The application is being developed with Flutter for both Android and iOS. Google ML Kit is employed for on-device OCR to extract data from scanned blood reports. Python-based AI models built with TensorFlow, scikit-learn, and NLP are being optimized for mobile deployment using TensorFlow Lite. Firebase supports cloud storage, authentication, and notifications. Key features include multilingual support (Sinhala, Tamil, English), health history tracking, voice summaries, emergency alerts, wearable connectivity, doctor-sharing, and encrypted local storage.

Results & Discussion: Prototype testing to date indicates promising outcomes. Preliminary evaluations showed OCR extraction accuracy of around 90%, with classification performance expected to reach over 85% accuracy once the final model is trained. Planned user studies will further assess comprehension, usability, and the impact of voice summaries and visual explanations on health literacy.

Conclusion: The app shows strong potential to simplify medical data and support preventive healthcare. Future work will finalize model training, broaden test coverage, and enable real-time record integration, enhancing accessibility, especially in underserved communities.

Keywords: Artificial Intelligence, Blood report interpretation, Mobile health application

A Mobile-Based Object Detection Approach to Support Navigation for the Visually Impaired

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Introduction: People with visual impairments often struggle to move around safely, especially in unfamiliar places. Many current assistive technologies are either expensive, require extra wearable devices, or depend on another person's help. Smartphones, however, are already widely available and powerful enough to run Artificial Intelligence (AI) models. This study presents a mobile application that uses only a smartphone to provide real-time object detection and simple guidance, helping users navigate more independently.

Objectives: The goal of this research is to design and develop an AI-powered mobile app that can detect nearby objects and provide navigation cues through audio feedback. The app is built to work offline and includes a simple, accessible interface so that visually impaired users can rely on it without needing any extra equipment.

Methodology: The app was developed using a YOLO-based AI model optimized with TensorFlow Lite for mobile devices. The phone's camera captures the surroundings, and the app processes the video to recognize obstacles. Once detected, the system provides audio alerts. The interface was created following accessibility guidelines to ensure ease of use, and test the system for speed, accuracy, and overall usability.

Results & Discussion: Early results show that the app can detect everyday obstacles with about 82% accuracy and runs smoothly at 8–10 frames per second on average smartphones. Audio feedback was almost instant, with less than a second of delay. In initial trials with visually impaired users, participants reported feeling more confident when moving through familiar spaces. Compared to existing wearable devices, this solution is more affordable and easier to carry.

Conclusion: This work shows that smartphones alone can be turned into practical navigation aids for visually impaired people. The unique value of this approach is that it provides reliable, offline object detection without requiring extra hardware.

Keywords: Accessibility, Assistive technology, Object detection, Visual impairment

AI-Powered Skin Care Application: Personalized Beauty Solution for Skin

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Introduction: There is a gap in personalized beauty care solutions due to the prevalence of skincare issues and limited access to expert dermatological counsel. This study proposes the concept and development of Glowify, a novel AI-based mobile application that integrates personalized skincare diagnostics, tele-specialist consultations, and salon bookings into a single platform.

Objectives: This study is driven by three major objectives, developing an online consulting system with matching clients to licensed skincare professionals and 70% customer satisfaction by month eight. Incorporate appointment booking features with more than 80% of people utilizing the tool for booking salons within ten months. Attain a minimum of 80% precision of AI-detected skin conditions (dryness, acne, wrinkles) compared to expert dermatological examination within six months.

Methodology: The platform was developed with Flutter for mobile app development, TensorFlow Lite for in-device AI inference, and Firebase for real-time processing of data under the hybrid Agile–Spiral development approach. The app cycle consists of user registration, taking photos, AI-driven skin analysis, virtual consultations with skin experts, and easy appointment booking. A mixed-methods approach integrates quantitative testing of AI performance and qualitative testing of user adoption and satisfaction.

Results & Discussion: The study provided an intuitive AI-based healthcare application that strengthen skin testing, specialist consultation, and salon booking into a complete end-to-end solution. The AI model, trained on real-life skin data, was over 80% precise in identifying wrinkles, dryness, and acne, meeting the project's functional goal. The consultation module, built on APIs, effectively matched users with skin experts, while the Firebase-powered booking functionality enabled over 80% of users to book salon sessions successfully.

Conclusion: With increasing digitalization of the healthcare sector, this research highlights the potential for democratisation of professional skincare through advanced AI by offering correct, actionable, and personalized recommendations for seekers of an all-round beauty remedy.

Keywords: Artificial Intelligence, Convolutional Neural Networks, Natural Language Processing, Virtual assistant

Tourist Management System for Sri Lanka an Integrated Solution for Tour Planning and Management

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Introduction: Sri Lanka, a popular tourist destination, lacks a unified digital platform for managing tourism services. This project introduces a web-based Tourist Management System to help foreign visitors plan customized tours, book hotels, and select local guides, while empowering service providers to manage bookings and enhance overall tourism efficiency.

Objectives: To develop and execute a web based TMS that is user friendly to international tourists. To allow individual planning of tours, bookings in the hotels and guides and make sure the payments online. To offer role-based dashboards to tourists, guides, hotel owners and administrators. Integrate a predictive analytics model to identify tourism trends and personalize recommendations. To verify the service by the administrators to enhance trust and reliability.

Methodology: The platform was constructed using PHP and a MySQL database on the back end using a responsive web on the front end, using HTML, CSS, JavaScript and Bootstrap, creating role-based access for tourists, guides, hotels owners and admin. The Random Forest model was trained on a tourism dataset from Mendeley Data to predict peak travel seasons and popular destinations.

Results & Discussion: The system achieved all objectives by allowing tour planning, secure and flexible payments, and access to some features based on role. Admin verification of services allowed the tour operator to verify services, while the Mendeley dataset was very effective when the Random Forest model effectively identified, peak months for travel and destinations of preference.

Conclusion: The system enhances Sri Lanka's tourist administration by streamlining service delivery, and it has the potential for future developments such as mobile integration and live tracking services, which will increase usability and provide insights to academics and the tourism sector. Users can avoid unreliable providers by using verified tour guides and hotel services.

Keywords: Booking system, Payment integration, Role-based dashboard, Tourist management system, Tour planning

The Role of Artificial Intelligence in Real-Time Malware Detection and Prevention over Public Wi-Fi Networks

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Introduction: Using public Wi-Fi in places like cafés, hospitals, or airports is convenient but exposes users to serious cybersecurity risks. Public Wi-Fi is generally open and unsecure, which makes it easier for attackers to launch malware attacks. Hackers can transmit malicious software to devices without user knowledge, enabling data theft, activity tracking, or complete system takeover. Traditional security solutions often lack the ability to detect such threats in real-time. Artificial Intelligence (AI) offers a more effective solution by enabling immediate detection and prevention.

Objectives: This study investigates the potential of AI to protect users from malware attacks during public Wi-Fi usage. Specifically, it aims to: (1) analyze how malware spreads through public networks, (2) evaluate how AI algorithms detect malicious activity faster than conventional systems, and (3) demonstrate how AI can stop attacks before they cause harm through real-time monitoring of network traffic on connected devices.

Methodology: A prototype AI-driven malware detection system was developed and tested in a simulated public Wi-Fi environment. Machine learning algorithms such as Random Forest, SVM, and KNN, along with deep learning algorithms like ANN and RNN, were applied to network traffic data. The system analyzed anomalous patterns and detected emerging threats with high accuracy.

Results & Discussion: The prototype system achieved faster, and more precise detection compared to traditional antivirus tools. AI models identified abnormal behavior within seconds and blocked malicious activity before data compromise occurred. Moreover, the system demonstrated adaptive learning, improving detection against new and evolving threats. Key challenges included minimizing false positives and ensuring scalability in large networks.

Conclusion: The developed AI-based malware detection system proved to be highly effective in securing devices on public Wi-Fi. By enabling real-time detection and automatic response, it strengthens protection against increasing cyber threats.

Keywords: Artificial Intelligence, Cybersecurity, Malware detection, Public Wi-Fi, Real-time protection

AI for Real-Time Hearing Loss Compensation

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Introduction: Hearing loss affects over 1.5 billion people worldwide and only 5% of them are using hearing aid. Around 70% of hearing loss affected people have Partial Hearing Loss (PHL) where the patient cannot hear certain sounds or frequencies, but they are not completely deaf. Most traditional hearing aids amplify boosted frequencies uniformly. They do not adjust to environmental variabilities and reconstruct or fill in frequencies to restore missing spectral components.

Objectives: An AI-powered, wearable auditory enhancement system analyzes the incoming sounds and automatically personalizes the model for addressing individual needs in real-time calibration. This solution is reconstructing the inaudible frequencies based on the user profiles and dynamically adjusting with environments.

Methodology: To address this, we proposed a wearable device powered by a Pixel 4 development board that captures ambient sound and streams it to cloud-hosted AI models for Adaptive Sound Reconstruction (ASR). The device uses Android's low-latency audio framework, with latency below 20 ms to handle real-time capture and playback, while cloud-based Deep Learning (DL) models reconstruct the missing frequencies and each user's hearing profile and listening environment.

Results & Discussion: ASR uses Deep Learning and Digital Signal Processing (DSP). DL models can adopt an STFT-based U-Net architecture and be trained on large speech/noise datasets such as LibriSpeech, VCTK, or AVSpeech with supervised learning algorithms. Limitations include high power use (14 h battery) and reliance on stable Wi-Fi/4G. Latency (50 ms) can be reduced through proposed edge deployment.

Conclusion: ASR gives people with hearing loss a more natural listening experience and reduces the social isolation caused by not being able to follow conversations clearly.

Keywords: Adaptive Sound Reconstruction, Deep Learning, Digital signal processing, Partial hearing loss

Attendance Management System using AI Based Face Recognition Technology Integrated with CCTV

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Introduction: Traditional biometric attendance tracking systems have drawbacks like the need for physical contact, hygienic issues, and manipulation vulnerability. Modern substitutes are made possible by the development of computer vision and Artificial Intelligence (AI). To provide institutions with scalable and hygienic tracking, this research focuses on creating an intelligent, contactless attendance management system that is integrated with the current CCTV infrastructure.

Objectives: The primary objective is to develop an AI-powered attendance management system that enables touchless attendance logging by using CCTV feeds for real-time facial recognition. The system is made to be safe, GDPR-compliant, and flexible enough to be used in a variety of institutional settings, such as offices, hospitals, and schools.

Methodology: A Python-based AI backend employing Haar-Cascade classifiers and LBPH (Local Binary Pattern Histogram) for facial recognition is integrated with a MERN (MongoDB, Express, React, Node.js) stack. CCTV footage is processed in real time to verify and identify people. Administrators can view attendance analytics, train the model, and manage student data via a web dashboard. For centralized data access and reporting, the system integrates with the cloud.

Results & Discussion: Automated attendance recording, batch-level analytics, and pattern recognitions such as tardiness or irregular attendance are all supported by the system. Supporting up to 50 concurrent users, performance metrics include a server response time of less than 500ms and a user interface rendering time of less than 5 s. Under ideal lighting and camera conditions, beta testing in educational institutions showed high usability, scalability, and accuracy of above 80% with Realtime database & dashboard updates.

Conclusion: The project effectively illustrates a contactless, secure, and scalable attendance system appropriate for organizations looking to update their administrative processes. Future improvements will include facial spoof detection, mobile app integration, and sophisticated predictive analytics for correlation between academic performance.

Keywords: AI, Attendance management system, CCTV, Face recognition, GDPR compliance

AI based Tailor Shop

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Introduction: The challenges faced in Sri Lankan textile industry are the necessity to ensure exact measurements, high cost of the fabrics, lack of skilled stylists and wastage of the fabrics generated based on the errors made by manual estimations. The Tex Tailor Shop project applies AI to simplify the process of dressmaking by women by providing the opportunity to estimate the material at home correctly, eliminating the need to consult a specialist and waste of materials. This strategy is inspired by the work done regarding the use of AI to estimate body size and fit clothes.

Objectives: Create an AI application to predict the fabric need of dresses available in different sizes (S to XXXL) to women. Give other suggestions of garments and create simple design sketches in the case of inadequate fabric. Test the accuracy and usability of the system regarding various body types of Sri Lankan residents.

Methodology: Create an AI application to predict the fabric need of dresses available in different sizes (S to XXXL) to women. Give other suggestions of garments and create simple design sketches in the case of inadequate fabric. Test the accuracy and usability of the system regarding various body types of Sri Lankan residents.

Results & Discussion: Artificially intelligent system forecasted the requirement of fabric with an accuracy of 85 percent based on the simulated data; it proposed other options such as blouses and simple sketches when fabric was not available, which helped in decision-making and sewing. The limitations include sketch quality and inability to test in the real world. It is planned to use improved sketches in the future with the help of advanced AI and real-life verification.

Conclusion: By using AI to check fabric and sketch dresses, Tex Tailor Shop helps both customers and tailors manage their time. Live measurements could be added by cameras in the future to enhance the shop.

Keywords: Artificial Intelligence, Clothes, Fabric, Measurements, Sewing

AI-Driven Health Management Platform for Chronic Disease Patients in Sri Lankan Public Hospitals.

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Introduction: Chronic diseases such as diabetes, hypertension, and cholesterol disorders place a severe burden on Sri Lanka's public healthcare system, where hospital congestion, lack of efficient patient monitoring, and language barriers (Sinhala/Tamil) remain major challenges. This research proposes MediPredict-SL, an AI-driven bilingual health management platform designed to optimize chronic disease management in Sri Lankan public hospitals. The system integrates OCR-based laboratory report analysis, AI risk prediction models, and chatbot-driven patient–doctor communication in Sinhala.

Objectives: The project aims to achieve five main objectives which include: Creating a React-based mobile and web application for chronic disease patients in public hospitals; Integrating AI/ML systems to analyze monthly lab reports; Creating doctor-facing health summaries and patient-facing chatbot advice in Sinhala; Allowing secure, role-based QR access for pharmacists and doctors; and Allowing real-time lab and device data integration.

Methodology: Combines qualitative and quantitative approaches, including 15 patient and 10 doctor interviews, hospital observation sessions, and simulation using synthetic datasets derived from WHO and Ministry of Health NCD statistics. Patient data security is ensured through AES-256 encryption, QR-based access control, and compliance with Sri Lanka's Personal Data Protection Act (2022).

Results & Discussion: Initial simulations, based on synthetic datasets derived from Sri Lankan public health reports, project a 40% reduction in unnecessary clinic visits, faster prescription generation via graphical doctor dashboards, and improved patient engagement through localized AI chatbot feedback. The diabetes risk prediction model achieved 82% accuracy with an AUC of 0.85 in simulation testing, demonstrating technical feasibility even without full real-world deployment.

Conclusion: This research fills a crucial gap in Sri Lanka's healthcare landscape by combining AI-driven analytics, bilingual NLP, and secure patient data flow into a single platform. A pilot study with real patients is planned for future validation to strengthen empirical evidence.

Keywords: AI, Chronic disease, Public healthcare, QR integration, Sinhala chatbot

Smart AI-Powered Bot for Mental Health Monitoring and Personal Development using Daily Text Analysis

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Introduction: Mental health difficulties are increasingly prevalent, especially among youth with limited access to support. In Sri Lanka, social traditions mostly block open discussions about mental health. This study explores the development of a friendly AI chatbot that uses multilingual input to identify emotions and support personal development. The goal is to build an emotionally intelligent, supportive digital companion.

Objectives: To develop a multilingual AI chatbot that detects emotional patterns in daily text, offers personalized feedback, and fosters emotional well-being and personal growth.

Methodology: Approximately 1,000 anonymized data sets from surveys are used in an iterative, user-centered prototype. Tokenization, normalization, stopword removal, and code-switching will be handled via preprocessing, and a multilingual BERT model will be optimized for emotion classification. Accuracy and F1-score are used to validate the chatbot's real-time insights and responses prior to more extensive testing.

Results & Discussion: It is anticipated that the technology will recognize emotions and offer sympathetic input. It is expected that participants will show positive participation, more self-reflection, and more awareness, even though they have trouble with informal and code-switched writing. This will show that multilingual emotion detection can be used to help people feel better.

Conclusion: The chatbot, while still under development, is anticipated to be an accessible and culturally aware mental health tool. Included are ethical protections for secrecy, privacy, and their supplementary—not replacement—role. Future research will combine counseling, expand datasets, increase accuracy, improve personalization, and evaluate long-term effects.

Keywords: AI powered bot, BERT model, F1-score , Natural Language Processing

A Rule-based Classification Module for Initial Phishing Awareness Assessment in the Non-IT Sector

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Introduction: The monolithic paradigms of cybersecurity training are inadequate for addressing the diverse knowledge levels found among personnel, often resulting in ineffective outcomes. This study presents a deterministic classification module, a central pre-processing component of the framework called "BehaveNex", which involves the algorithmic stratification of the personnel according to the initial threat-assessment capabilities, thus allowing a second, highly personalized training pipeline.

Objectives: This study was aimed to architect a deterministic algorithm that maps continuous assessment scores to discrete, ordinal awareness categories and construct a computationally efficient, fully explainable "white box" classifier suitable for enterprise deployment.

Methodology: System architecture is a knowledge-based module that takes a normalized score of a standardized 20-question assessment. Its fundamental logic utilizes a collection of fixed, professionally deployed sets of heuristic rules that act as classification thresholds. The change of data is performed through conditional comparisons of this threshold, and the actual continuous input value is algorithmically projected into three discrete output labels 'Beginner', 'Intermediate', and 'Advanced'.

Results & Discussion: A preliminary evaluation was conducted with a pilot group of users, where the module demonstrated high reliability in its classifications. The engine's logic was also validated for 100% accuracy in rule execution. For example, the heuristic rule for the 'Beginner' class is triggered by scores $\leq 40\%$. This represents a failure to identify fundamental threat indicators like a spoofed email domain. Therefore, a user unable to identify these key features receives a low score and is algorithmically classified as a 'Beginner.'

Conclusion: This study has succeeded in the engineering of a classifier that was optimized based on the requirements of algorithmic transparency and efficiency. Future research will examine a hybrid approach in which static heuristics are actually changing dynamically through dynamic K-Means clustering analysis of cumulative performance records.

Keywords: Cybersecurity training, Employee assessment, Personalized learning, Phishing awareness, Rule-based classification

Cloth Compensation Algorithms for Accurate Body Measurement Extraction from 2D Images

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Introduction: Accurately restoring body measurements using 2D images plays a vital role in the fitting of a specific item of clothing. However, fitting any loose or layered clothing inherits many inaccuracies in measurements, as the actual garment does not reflect the body shape. Traditional systems tend to ignore these errors, but intelligent algorithms that cover such discrepancies and provide tailor-level accuracy for remote measurement systems are increasingly in high demand.

Objectives: This paper seeks to propose and test an innovative cloth compensation algorithm measuring and correcting deviations of loose or draped clothes in 2D bodies images delivered to remote tailoring.

Methodology: The offered compensation algorithm takes advantage of dual-image data (tight-fitting and clothed images) and the segmentation methods based on machine learning to separate clothing areas with real body outlines. The difference in the key body landmarks of both the images is analyzed to give the correction factors to be used in the final extraction of the measurements through a dynamic ratio calibration. The mixed dataset containing images with less clothing and clothed was used to test the system which was illuminated in differently varying conditions.

Results & Discussion: The cloth compensation algorithm successfully extracted eight body dimensions from 2D images, including chest circumference 92 cm, body length 162.67 cm, and shoulder width 13.48 cm. The system integrated a 6cm garment ease allowance and achieved 15-20% measurement accuracy improvements over traditional methods. Testing across different clothing types demonstrated consistent performance under varying environmental conditions.

Conclusion: This research demonstrates that dual-image cloth compensation algorithms significantly enhance measurement precision in remote tailoring, achieving automated extraction of eight body dimensions with 6 cm ease integration. The system delivered measurable accuracy improvements by compensating for garment-induced measurement distortions in online fitting applications.

Keywords: Body measurement, Cloth compensation, Custom clothing, Image processing

Faculty of Health Sciences

Microencapsulation of Instant Tea Incorporated with Pepino (*Solanum muricatum*) Fruit Extract: A Comparative Study of Spray and Freeze Drying with Different Wall Materials

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Introduction: Pepino is used as a remedy for diabetes mellitus, sprue, and hypertension due to its antioxidant, anti-inflammatory, and antidiabetic properties, making it a promising ingredient for developing functional tea. Instant tea production relies on refuse tea (Broken Mixed Fannings) due to its cost-effectiveness.

Objectives: To develop functional instant tea with Pepino using microencapsulation technique and to evaluate the efficiency of drying methods with different wall materials.

Methodology: Small pieces of ripen-Pepino were tested with 6 treatments to select the best method to prevent enzymatic-browning and extract was obtained by pressing the heated Pepino. Pretreated-Pepino together with black tea and wall material was microencapsulated to obtain 3 spray-dried formulations: F1 (Gum Arabic-GA); F2 (inulin-IN); F3 (GA+IN) and 3 freeze-dried formulations: F4 (GA); F5 (IN); F6 (GA+IN). All formulations were evaluated for physicochemical, functional (DPPH assay), and sensory properties.

Results & Discussion: Pretreatment of Pepino with 0.1% citric acid followed by high temperature short time pasteurization (72±5 °C,15 sec) prevented browning. The highest lightness (L*=85.32) and yellowness (b*=36.64) were recorded by F4 and F3, respectively. All formulations recorded positive a* values (redness) ranging between 3.98-14.55. The pH ranged between 4.67-4.89. F1 reported the lowest haze (43.75 NTU). All formulations had moisture content <6 (w/w), conforming to ISO 6079:2021. Freeze-drying was effective in retaining phenolic compounds. Formulation F5 reported a higher total phenolic content (22.02 mg GAE/g) than F2 (17.87 mg GAE/g). Under freeze-drying, inulin alone showed higher antioxidant activity (IC_{50}=186.90 ppm) and encapsulation efficiency (48.72%) than GA or its combination with GA. Formulation F2 was the most preferred during sensory evaluation, earning the highest ratings for appearance, color, aroma, and mouthfeel. It reported 8.36% ash and 8.196 mg/mL caffeine content. Red blood cell hemolysis assay reported a very low hemolysis% (0.98%) indicating its non-toxicity.

Conclusion: Among the tested formulations, F2 and F5 demonstrated the best combination of functional and sensory properties, highlighting their potential for sustainable functional instant tea production.

Keywords: Drying method, Instant tea, Microencapsulation, Pepino, Wall materials

Green Synthesis of Silver Nanoparticles using *Clitoria ternatea* L. for Antibacterial Activity

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Introduction: *Clitoria ternatea* L. is a medicinal plant that possesses antibacterial activity. Green synthesis of silver nanoparticles (AgNPs) using plant extracts offers a sustainable approach with reduced toxicity and minimum environmental impact.

Objectives: To synthesize and characterize the silver nanoparticles using *C. ternatea* extract and to evaluate the antibacterial activity using the disk diffusion method.

Methodology: The dried flowers (0.02 g) of *C. ternatea* were subjected to prepare a plant extract by boiling in 20 mL of distilled water. The silver nitrate solution (3 mM) was added dropwise to *C. ternatea* extract under controlled temperature (50℃) to synthesize AgNPs and the prepared nanoparticles were characterized using UV-Vis spectroscopy, Dynamic Light Scattering (DLS), Fourier Transform Infrared Spectroscopy (FTIR) and X-ray Diffraction (XRD). The antibacterial efficacy of the prepared nanoparticles was evaluated using the disc diffusion method against *Escherichia coli* (ATCC 25922) and *Staphylococcus aureus* (ATCC 25923).

Results & Discussion: The brown colour indicated the formation of AgNPs and was further proved by the absorption peak at 430 nm in UV-Vis spectroscopy. According to DLS analysis, the resultant nanoparticles were 125.3 nm in size and according to the FTIR, a prominent peak at 3280 cm^{-1} due to the reduction of Ag^+ to Ag^0 in the presence of anthocyanins was observed. The XRD revealed the well-dispersed cubic crystalline structure of NPs with a 10–30 nm diameter. For the antibacterial assay ciprofloxacin was used as the positive control and all the samples showed antibacterial activity. The average inhibition zones observed were 12.1±0.14 mm and 12.55±0.07 mm against *E. coli* and *S. aureus* respectively.

Conclusion: The green synthesis of AgNPs using *C. ternatea* offers a reliable source for the development of antibacterial agents.

Keywords: Antibacterial activity, *Clitoria ternatea*, Green synthesis, Silver nanoparticles

Phytochemical Screening of Different Parts of the *Costus speciosus* L. Plant

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Introduction: *Costus speciosus* L. is a medicinal plant used to treat various non-infectious diseases due to its many pharmacological properties and is widely distributed in South Asia.

Objectives: To investigate the phytochemicals qualitatively of the whole plant of *C. speciosus* and parts of *C. speciosus* followed by screening of phytochemicals by using the thin layer chromatography (TLC).

Methodology: *C. speciosus* plant was dried and separated into baby leaves, mature leaves, and stem. The Soxhlet extraction technique was used to extract 5 g of each dried plant sample using absolute methanol (250 mL) as the solvent, followed by evaporation of the solvent to dryness using a rotary evaporator. Qualitative phytochemical analysis was conducted on the whole plant and each part of the plant (1000 ppm) using standard tests. The TLC analysis was performed using hexane:ethyl acetate (4:1, v/v) as the solvent mixture and was visualized under UV light (280 nm).

Results & Discussion: The total plant and each part showed a variety of phytochemicals. Both total plant and baby leaves consist of tannins, terpenoids, steroids, saponins, flavonoids, phenolics, and alkaloids as secondary metabolites and mature leaves contain tannins and phenolics but lack saponins and alkaloids. The red stem showed no detectable phytochemicals, indicating low secondary metabolite presence. According to the TLC analysis, five separated spots were identified, and three separated spots were identified in baby leaves and mature leaves accordingly. But neither spot was detected for the stem.

Conclusion: The *C. speciosus* plant consists of a rich phytochemical profile and baby leaves consist of a variety of phytochemicals compared to the mature leaves as indicated by the TLC profile. The stem does not contain secondary metabolites at a delectable limit. Since baby leaves of *C. speciosus* indicated a potent source for medicinal and pharmacological use.

Keywords: Bioactive compounds, *Costus speciosus*, Medicinal plants, thin layer chromatography

Determination of Sun Protecting Factor of Green Synthesized ZnO Nanoparticles Using *Leucas zeylanica* L. and Chemically Synthesized ZnO Nanoparticles

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Introduction: Ultraviolet (UV) radiation poses significant risks to skin health, contributing to conditions such as photoaging and skin cancer. Sunscreens containing zinc oxide (ZnO) nanoparticles have become crucial in skin care for their broad-spectrum UV protection.

Objectives: To analyze the Sun Protecting Factor (SPF) of environmentally friendly green-synthesized ZnO nanoparticles using *Leucas zeylanica* L. extract and chemically synthesized ZnO nanoparticles.

Methodology: The dried leaves of *L. zeylanica* were subjected to maceration using absolute ethanol. Zinc acetate ($0.02 \mathrm{~mol~dm}^{-3}$, 2.50 mL) was added dropwise to the crude extract (1.0 mL, 0.05 g/mL) for the synthesis of ZnO nanoparticles of *L. zeylanica* under controlled conditions. Chemically synthesized ZnO nanoparticles was synthesized by dropwise addition of zinc acetate ($0.05 \mathrm{~mol~dm}^{-3}$, 25.00 mL) to sodium hydroxide ($0.1 \mathrm{~mol~dm}^{-3}$, 25.00 mL) under controlled conditions and was subjected to thermal treatment at 90°C. Both types of nanoparticles were characterized by UV-visible spectroscopy, particle size analysis to confirm that the nanoparticles are on the nano scale and followed by Fourier Transform Infrared Spectroscopy (FTIR). The SPF value was calculated using the Mansur equation.

Results & Discussion: A prominent peak at 320 nm proved in UV-Vis spectroscopy is specific for ZnO nanoparticles and prominent peaks at 1030 cm-1,1411 cm^{-1} and 2900 cm^{-1} in FTIR analysis due to the phytochemical stabilization of ZnO nanoparticles and functional groups for the prepared nanoparticles. The chemical synthesized nanoparticles showed a SPF value of 18.6 and the green synthesized nanoparticles showed a SPF value of 13.6.

Conclusion: Chemically synthesized ZnO nanoparticles had superior sun protection due to large surface area to volume ratio and green-synthesized ZnO nanoparticles offer a sustainable alternative with moderate SPF potential. Future studies should focus on optimizing the green synthesis process to enhance UV protection capabilities with toxicity to offer a viable solution for natural sunscreen formulations.

Keywords: Green synthesis, *Leucas zeylanica*, Sun protection factor, ZnO nanoparticles

Evaluating the Efficiency of Dip Coating for Nanoparticle Integration in Cosmotextiles: A Narrative Review

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Introduction: Integration of nanoparticles into textile materials has the potential to offer biological properties such as antibacterial, antifungal and UV protection. There are many techniques that have been used to integrate nanoparticles into textile materials, but dip coating method stands out as one of the simplest and most cost-effective approaches. However, the effectiveness of the dip coating method for nanoparticle integration remains underexplored.

Objectives: The main objective of this study is to review the efficacy of the dip coating method for incorporating nanoparticles into cosmotextile applications.

Methods & Analysis: A review study was conducted from databases such as Google Scholar and ResearchGate ranging from 2021 to 2024. The search term included "Dip coating method of integrating nanoparticles into cosmotextiles". The data extracted for the use of dip coating method under varying conditions of immersion time, withdrawal speed, and drying temperature. The review was further expanded to include characterization results of the coated fabrics using Scanning Electron Microscopy (SEM) for surface morphology, Fourier-Transform Infrared Spectroscopy (FTIR) for bonding analysis, and the biological impact of coated fabrics for antibacterial, antifungal, and UV protective performance. The dip-coated fabrics showed uniform nanoparticle distribution under optimal process parameters. SEM analysis confirmed the proper surface adhesion, while FTIR indicated possible chemical interactions between nanoparticles and fabric material. The treated textiles exhibited significant antibacterial activity against *Escherichia coli*, antifungal activity against *Candida albicans*, and enhanced UV protection. However, repeated washing led to reduced activity, suggesting that the durability of the nanoparticle coating remains a challenge and requires further improvement.

Conclusion: Dip coating proves to be an effective technique for providing antimicrobial and UV protective ability in cosmotextiles. But future studies should focus on long term durability of the coated fabrics to enhance their overall effectiveness. These findings contribute to developing functionalized textile materials to provide biological properties.

Keywords: Antimicrobial, Cosmotextiles, Dip coating, Nanoparticles, UV protective

Impact of Shifting from an Omnivore to a Vegetarian Diet on Texture Preferences

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Introduction: Vegetarianism has started to gain more popularity as a dietary style, to a point where it has now become a rapidly growing global phenomenon. While adopting a vegetarian diet is believed to influence sensory preferences, including texture preference, empirical evidence remains largely unexplored.

Objectives: To investigate how a shift from an omnivore to a vegetarian diet influences food texture preference, using an interventional approach.

Methodology: A randomised controlled intervention was conducted with 30 individuals (calculated using G-Power 3.1.9.7 software, effective size=0.45; obtained from previous literature to detect a medium-sized effect with 80% power), who had been followed an omnivore diet for more than three years (age: 21-40 years). Participants were randomly assigned to either a control (n=15), maintaining their usual omnivore diet, or an interventional group (n=15), adopting a vegetarian diet for the 12-weeks study period, under the supervision of a qualified nutritionist. Participant preference towards meat-related food textures was evaluated using CATA, before and after the intervention, since these meat-related textures (e.g., tough, fibrous) could reflect the sensory satisfaction obtained from omnivore diet compared to vegetarian diet.

Results & Discussion: The results showed that, following the intervention, the participants of interventional group had significantly changed the preference towards meat-related textures such as crispy (p=0.046), tough (p=0.046) and fibrous (p=0.025) after 12 weeks of intervention period, while the textures such as tender (p=0.058), chewy (p=0.564), and paste-like (p=0.564), did not significantly changed. The control group showed no significant difference regarding their preference on any of the meat-related textures (all p>0.1).

Conclusion: Transitioning from an omnivore to a vegetarian diet reduces preference for crispy, tough, and fibrous food textures while the preference towards tender, chewy and paste-like remains same. Our study provides valuable insights for nutritionists, policymakers, and individuals considering dietary transitions for health or sustainability reasons.

Keywords: Omnivores, Sustained vegetarian diet, Texture preference, Vegetarians

Texture Perception and Food Neophobia is Not Linked with Childhood Weight Status: Evidence from Sri Lanka

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Introduction: The prevalence of both underweight and overweight conditions has been a significant public health concern worldwide over the past few decades, specifically in children. It has been identified that the fear or reluctance to try unfamiliar food (a.k.a. food neophobia) and perception of food texture play crucial roles in shaping childhood diet and in turn their weight status, amidst limited empirical findings.

Objectives: This study, therefore, aimed to evaluate the links between food neophobia and texture preferences and the weight status of children in Sri Lanka.

Methodology: A total of 175 children, aged between 9-11 years, were recruited into the study. During the study, children's preference for different food textures were assessed using a validated questionnaire, while food neophobia was assessed using a 10-item food neophobia scale developed by Pliner and Hobden in 1992. Additionally, children's BMI was used as anthropometric measures, and divided them to underweight, normal weight, and overweight groups. Data were analysed using ANCOVA adjusting for gender, income level, physical activity level, and birth weight.

Results & Discussion: Our results revealed no significant differences in preference for any of the tested textures (i.e., soft, hard, smooth, rough, solid, liquid, crispy, crunchy, lumpy, and gritty) between the BMI groups (underweight = 12.60±0.79 kg/m^2, normal weight = 15.69±1.50 kg/m^2, overweight = 22.02±2.79 kg/m^2). Additionally, no significant difference in Food neophobia was detected across the BMI groups (p>0.05).

Conclusion: These findings suggest that there is no clear relationship between BMI and the preference for specific food textures or food neophobia, highlighting that children's weight status might be influenced by other factors, without directly impact these aspects of food preference and behaviour. This enables healthcare professionals and policymakers to address this critical health crisis more effectively, thereby enhancing the health status of children and promoting social well-being.

Keywords: Children, Food neophobia, Texture perception, Weight status

In Silico Exploration of Phytochemicals in Selected Sri Lankan Medicinal Plants as Selective COX Inhibitors for Primary Dysmenorrhea: A Molecular Docking Study

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Introduction: Cyclooxygenase (COX) enzymes are key mediators of prostaglandin mediated inflammation and pain, making them primary targets for nonsteroidal anti-inflammatory drugs (NSAIDs) in treating dysmenorrhea. Due to the adverse effects of long-term NSAID use, alternatives are sought.

Objectives: To explore the therapeutic potential of phytochemicals of, *Glycyrrhiza glabra* L. and *Nymphaea nouchali* plants, through comprehensive molecular docking analysis.

Methodology: The selected protein targets, COX-1 (PDB ID: 3N8W) and COX-2 (PDB ID: 5F19) were retrieved from the RCSB Protein Data Bank and optimized through homology modeling using SWISS-MODEL to complete the missing residues. Active sites were identified using PrankWeb server for targeted molecular docking. Phytochemical structures from PubChem, were geometry-optimized using ArgusLab 4.0.1 and docked into active sites using PyRx 0.8, employing AutoDock Vina. Binding energies and interaction profiles were compared against reference drugs (ibuprofen and mefenamic acid) to assess relative inhibitory potential.

Results & Discussion: For COX-1 and COX-2; Shinflavanone (-7.0 kcal/mol; -9.2 kcal/mol), Hispaglabridin B (-7.1 kcal/mol; -9.0 kcal/mol), Hedysarimcoumestan C (-6.7 kcal/mol; -10.0 kcal/mol) from Glycyrrhiza glabra L., and Rhamnoside (-6.9 kcal/mol; -10.0 kcal/mol) from Nymphaea nouchali, were demonstrated much of balanced binding affinities to those of ibuprofen (-6.6 kcal/mol; -7.1 kcal/mol) and mefenamic acid (-7.9 kcal/mol; -7.0 kcal/mol), by forming favorable hydrogen bonds and hydrophobic interactions, suggesting strong inhibitory potential.

Conclusion: These phytochemicals, with their balanced COX-1 and COX-2 binding affinities, could serve as lead compounds for safer dysmenorrhea therapeutics. Further molecular dynamics simulations, ADMET profiling, and experimental validation are warranted to advance these compounds toward clinical applications.

Keywords: Cyclooxygenase enzymes, *Glycyrrhiza glabra*, *In silico*, *Nymphaea nouchali*

In Vitro Anti-inflammatory Effects and Safety Profiles of Aqueous and Methanol Extracts of *Peperomia pellucida*

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Introduction: Medicinal plants can be used as alternative medicines to alleviate inflammation. *Peperomia pellucida* (L.) Kunth is such a medicinal plant widely used for its anti-inflammatory activities.

Objectives: To assess the *in vitro* anti-inflammatory activity and safety profile of aqueous and methanolic extracts of *Peperomia pellucida* (L.) Kunth.

Methodology: Fresh aerial parts of *P. Pellucida* were refluxed separately with distilled water and methanol for two hours. These extracts were rotary-evaporated, and the resulting powders were used to prepare two separate dilution series (0.125 mg/mL - 5 mg/mL) in distilled water and methanol. Human red blood cell (HRBC) membrane stabilization assay and egg albumin denaturation assay were performed, and results were compared with the diclofenac sodium. The brine shrimp lethality assay was conducted to evaluate the safety profile of the extracts.

Results & Discussion: In HRBC assay, the highest inhibition of *in vitro* hemolysis by aqueous extract was observed at 5 mg/mL (88.42±1.31%), whereas the half maximal inhibitory concentration (IC50) was estimated as 0.9207 mg/mL. The methanol extract demonstrated 38.08±2.81% of inhibition at 5 mg/mL and its IC50 was 9.11 mg/mL. IC50 of diclofenac standard was 0.5148 mg/mL in the same assay. In egg albumin denaturation assay, the methanol extract showed an inhibition of 52.92±0.17% at 1 mg/mL and the IC50 was determined to be 0.8324 mg/mL. The aqueous extract showed a higher inhibition (66.38±0.16%) at the same concentration and the IC50 was found to be 0.2633 mg/mL. The mortality of Artemia nauplii reduced with decreasing concentrations of plant extracts and both extracts showed no mortality at concentrations below 0.5 mg/mL.

Conclusion: The aqueous extract of *P. pellucida* shows more potent anti-inflammatory properties than the methanol extract. Furthermore, the plant extracts exhibited less toxicity at lower concentrations, suggesting their potential for new therapeutic applications.

Keywords: Albumin denaturation, Brine shrimp, Membrane stabilization, *Peperomia pellucida*

Gut Microbiota Diversity of *Armigeres subalbatus* Mosquitoes Residing in Western Province, Sri Lanka: Diversity Index Analysis

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Introduction: *Armigeres subalbatus* mosquitoes host gut microbiota that influence blood meal digestion and pathogen transmission. Understanding their microbial diversity is crucial for elucidating their role in vector competence and disease control strategies.

Objectives: To identify the gut bacterial diversity of *Armigeres* mosquitoes residing in three districts (Colombo, Gampaha, and Kalutara) in Western Province, Sri Lanka, using Simpson's and Shannon diversity indices.

Methodology: Adult female *Armigeres* mosquitoes were sampled from breeding sites. Their midguts were dissected, homogenized in phosphate-buffered saline, and serially diluted up by 10-fold dilutions. The dilutions were plated on nutrient agar, incubated for 24 hours, and 27 bacterial isolates were identified using Gram staining, catalase, oxidase, and biochemical assays.

Results & Discussion: Five bacterial profiles were identified in *Armigeres subalbatus* gut microbiota: Profile A, *Staphylococcus* spp. (Gram-positive, catalase-positive, indole-positive, citrate-positive) with 21 isolates (7 Gampaha, 5 Kalutara, 9 Colombo); Profile B, *Escherichia* spp. (Gram-negative, catalase-positive, indole-positive, citrate-positive) with 1 isolate (Gampaha); Profile C, *Enterococcus* spp. (Gram-positive, catalase-negative, indole-positive, citrate-positive) with 3 isolates (1 Gampaha, 2 Kalutara); Profile D, *Staphylococcus* spp. (Gram-positive, catalase-negative, indole-positive, citrate-negative) with 1 isolate (Colombo); and Profile E, *Staphylococcus* spp. (Gram-positive, catalase-positive, indole-negative, citrate-positive) with 1 isolate (Colombo). The Shannon diversity index indicated low diversity (H 0.77 overall; 0.68 in Gampaha, 0.60 in Kalutara, 0.60 in Colombo). Simpson's Index ($D \approx 0.607$) showed moderate dominance by *Staphylococcus* spp., with the diversity index ($1 - D \approx 0.393$) confirming low to moderate diversity, supporting the Shannon findings. These findings suggest a dominance of a few bacterial types of *Staphylococcus* spp. in profile A, indicating a specialized gut microbiota possibly adapted to the ecological niche of *Armigeres* mosquitoes.

Conclusion: The gut microbiota of *A. subalbatus* exhibits low bacterial diversity, dominated by *Staphylococcus* spp., suggesting a specialized microbial community. Further, 16S rRNA sequencing could clarify their functional roles in vector competence and inform targeted disease control strategies.

Keywords: *Armigeres* spp., Gut microbiota, Shannon index, Simpson's index, Western Province

Assessment of Knowledge, Attitude and Practices of Iron Deficiency Anemia Among Youth in the Western Province, Sri Lanka

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Introduction: Iron Deficiency Anemia (IDA) is the most prevalent nutritional disorder, raised as a concern in the world burden among young populations due to unhealthy eating habits, low health awareness, and socio-economic inconsistencies. The Western province of Sri Lanka, where dietary changes, urbanization, and lifestyle transitions significantly impact the risk and treatment of iron deficiency anemia, has the most information on awareness and practices of youth population regarding IDA.

Objectives: To assess the Knowledge, Attitude, and Practice (KAP) regarding iron deficiency anemia and identify associated socio-demographic, dietary, and health behavior factors among youth aged 18–29 years in the Western Province of Sri Lanka.

Methodology: A cross-sectional descriptive study was carried out among 424 participants using a structured and validated web-based questionnaire. The analysis of the risk factors was performed with SPSS (version 25.0) employing Chi-square tests and logistic regression analysis to identify significant associations.

Results & Discussion: Results showed that IDA awareness was strongly correlated with gender and education levels ($p < 0.05$). The predictive variable for IDA probability was gender ($p = 0.012$), and a negative correlation between the consumption of iron-rich foods regularly and IDA diagnosis ($p = 0.013$). According to the results, the most common cause given for IDA in the selected sample was a lack of iron in the diet, and additionally, the most consumed sources of iron were spinach and red meat.

Conclusion: IDA awareness was significantly associated with both education level ($p < 0.05$) and gender, with regular consumption of foods high in iron lowering the probability of diagnosis and gender serving as a major predictor of IDA risk. To lower the prevalence of IDA, these findings highlight the necessity of focused nutritional interventions and health awareness campaigns among Sri Lankan teenagers.

Keywords: Iron deficiency anemia, KAP, Western province, Youth population

Determination of Anti-Biofilm Activity of *Diospyros malabarica* and *Syzygium caryophyllatum* Against Common Pathogenic Bacteria

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Introduction: Biofilm-associated infections lead to significant clinical challenge due to their structural complexity and intrinsic resistance to antibiotics and immune clearance, contributing to chronic infections in wounds, implants, and respiratory tissues.

Objectives: To evaluate the anti-biofilm potential of two traditionally used Sri Lankan medicinal plants, *Diospyros malabarica* (Thimbiri) and *Syzygium caryophyllatum* (Dan), against six pathogenic bacterial clinical strains, *Staphylococcus aureus* , *Escherichia coli*, *Klebsiella spp*, *Serratia spp*, *Pseudomonas spp* (MDR), and *Pseudomonas aeruginosa* (ATCC 10145).

Methodology: Methanolic and aqueous extracts were prepared from the bark and leaves of both plants using standard maceration and reflux methods. Anti-biofilm activity was assessed using the crystal violet staining assay. The optical density measured at 590 nm. Statistical analysis was done via SPSS 24.0, two-way ANOVA ($p < 0.05$).

Results & Discussion: *D. malabarica* and *S. caryophyllatum* crudes showed concentration-dependent biofilm inhibition across all six bacterial strains. *D. malabarica* aqueous extracts of bark and leaves synergism demonstrated notable efficacy, with the highest antibiofilm activity against S. aureus (67.7%) and *P. aeruginosa* (66.3%) respectively. Methanolic extracts also displayed considerable anti-biofilm activity against multidrug-resistant *Pseudomonas spp.* (65.3%), suggesting a broad-spectrum potential. The two-way ANOVA confirmed significant differences ($p= 0.0020$) ($p < 0.05$) between treated and control groups of anti-biofilm activity. Further methanolic leaf extracts of *S. caryophyllatum* achieved the highest (65%) against S. aureus confirming the methanolic extracts efficacy. The anti-biofilm efficacy is attributed to the presence of bioactive phytochemicals, particularly phenols and flavonoids which are known to disrupt quorum sensing, inhibit bacterial adhesion, and degrade the extrasellar biofilm matrix.

Conclusion: *Diospyros malabarica* and *Syzygium caryophyllatum* as potential natural anti-biofilm agents and their ability to inhibit and disrupt established biofilms of tested clinical strains. Further research into isolating specific bioactive compounds is important for possible development into therapeutic formulations.

Keywords: Anti-biofilm, Crystal violet assay, *Diospyros malabarica*, *Syzygium caryophyllatum*

Evaluation of Antioxidant and Antibacterial Properties of Leaf Extracts of *Andrographis paniculata* (L.), *Celosia argentea* (L.), and *Sphagneticola trilobata* (L.)

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Introduction: Medicinal herbs are increasingly required for their antioxidant and antibacterial activities. *Andrographis paniculata*, *Celosia argentea*, and *Sphagneticola trilobata* were included in this investigation due to their potential antibacterial and antioxidant qualities.

Objectives: To compare and assess the antioxidant and antibacterial prospects of aqueous and ethanol extracts of the leaves from the three chosen plant species.

Methodology: Leaves of all three plants were shade-dried, powdered, and extracted using cold maceration with distilled water and 95% ethanol. Antioxidant activity was determined using the DPPH assay and reported as inhibition (%) and IC_{50} values. Antibacterial activity was tested, based on inhibition zones, using agar well diffusion method against six bacteria, including *Escherichia coli*, *Staphylococcus aureus*, and *Pseudomonas aeruginosa*.

Results & Discussion: Ethanol extracts of *A. paniculata*, *C. argentea*, and *S. trilobata* exhibited significantly higher antibacterial and antioxidant activities than their aqueous counterparts ($p < 0.05$). Antibacterial tests were conducted at 200,000 ppm using ciprofloxacin (5 µg/disc) and gentamicin (10 µg/disc) as positive controls, and 1% DMSO as the negative control. Among ethanol extracts, *A. paniculata* showed the highest inhibition zones against *S. aureus* (15.2 ± 0.4 mm) and *E. coli* (13.4 ± 0.5 mm), while aqueous extracts were less active (6.8–9.1 mm). Antioxidant activity was measured using DPPH at concentrations of 30–210 ppm, with ascorbic acid (5–35 ppm) as positive control and 0.04 mM DPPH as negative control. The lowest IC_{50} among aqueous extracts was observed in *A. paniculata* (57.6 ± 1.05 µg/mL), followed by *C. argentea* (68.4 ± 1.12 µg/mL) and *S. trilobata* (76.3 ± 0.98 µg/mL). Ethanol extracts showed stronger activity, with lower IC_{50} values, indicating higher free radical scavenging potential.

Conclusion: Ethanol leaf extracts of *S. trilobata*, *A. paniculata*, and *C. argentea* demonstrated strong antioxidant and antibacterial activities compared to aqueous extracts and negative controls. *A. paniculata* showed the highest activity, confirming the greater efficacy of ethanol extracts at the tested concentrations.

Keywords: *Andrographis paniculata*, *Celosia argentea*, DPPH, *Sphagneticola trilobata*

Phytochemical Composition and *In Vitro* Anti-hyperglycemic Potential of Unripe Fruit of *Musa paradisiaca* L.

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Introduction: The unripe fruit of *Musa paradisiaca* L. is a commonly utilized food which is also reported to have many therapeutic properties in traditional medicine, including management of diabetes. alpha-amylase inhibitory activity can be used as a useful tool to assay the anti-hyperglycemic potential of medicinal substances.

Objectives: To evaluate the phytochemical composition and *in vitro* anti-hyperglycemic effect of the aqueous extract of unripe *M. paradisiaca* fruit.

Methodology: Dried plant materials of *M. paradisiaca* were authenticated by the National Herbarium, Peradeniya. Thin sections of unripe fruit of *M. paradisiaca* were observed under light microscopy. The dried fruit powder was macerated by soaking in distilled water overnight, followed by qualitative preliminary analysis of the extract to screen the phytochemistry. α-amylase inhibition was assessed through usual enzymatic assay. The concentration series was prepared in 13,330 µg/mL to 416 µg/mL dilutions. Acarbose was used as the positive control, and phosphate buffer (pH 6.9) was the negative control.

Results & Discussion: Transverse section of unripe fruit of *M. paradisiaca* showed outer single-layer epidermis made up of rectangle shaped parenchyma and a layer of creamy brown colour, spherical shape cells under light microscope. Qualitative phytochemical screening identified flavonoids, alkaloids, tannins, saponins, phenolics, and glycosides, which may contribute to the therapeutic effects of the plant fruit. The α-amylase inhibitory assay showed strong enzyme inhibition (IC_{50}: 192.61 ± 17.10 µg/mL) with 63.42 ± 1.75% of activity at the highest concentration, in comparison with acarbose (IC_{50}: 42.84 ± 17.12 µg/mL). One-way ANOVA followed by Turkey's post-hoc test revealed a statistically significant difference ($p < 0.05$) between the α-amylase inhibition of acarbose and *M. paradisiaca*.

Conclusion: *Musa paradisiaca* extract demonstrated moderate *in vitro* α-amylase inhibition, warranting further investigation for diabetes management.

Keywords: Alpha-amylase, Anti-hyperglycemic, Maceration, Phytochemical screening

In Vitro α-Amylase Inhibitory Activity of Selected Medicinal Plants: *Phyllanthus amarus*, *Mangifera indica*, and *Murraya koenigii*

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Introduction: Diabetes mellitus is a metabolic disorder marked by persistent hyperglycemia. *Phyllanthus amarus* Schumach. & Thonn., *Mangifera indica* L., and *Murraya koenigii* (L.) Spreng. are traditionally used common plants for diabetes management.

Objectives: To evaluate the in vitro α-amylase inhibitory activity of ethanol extracts of the whole plant of *P. amarus*, leaves of *M. indica*, and *M. koenigii*.

Methodology: The test extracts were prepared by Soxhlet extraction of 10 g of dried plant materials of *P. amarus*, *M. indica*, and *M. koenigii* separately for two hours using 200 mL of ethanol. Extracts were concentrated under reduced pressure, and serial dilutions (5000–156.25 µg/mL) were prepared. Qualitative phytochemical screening was conducted on each test extract. The α-amylase inhibition assay was performed using starch substrate, whereas acarbose was used as the positive control. Inhibition of enzyme activity by test substances and their IC_{50} values were recorded. One-way ANOVA followed by Tukey's post-hoc test was performed.

Results & Discussion: Phytochemical screening revealed saponins in all three extracts, alkaloids and flavonoids in *P. amarus* and *M. indica*, tannins in *P. amarus* and *M. koenigii*, and steroids in *M. indica* and *M. koenigii*. At 5000 µg/mL, *P. amarus* showed the highest α-amylase inhibition (70.67%), followed by *M. koenigii* (60.14%) and *M. indica* (58.67%). Statistical analysis confirmed that only *P. amarus* exhibited activity comparable to the positive control ($p > 0.05$). All three extracts exhibited a dose-dependent proportional enzyme inhibitory activity. The lower IC_{50} (60.79 ± 10.71 µg/mL) of *P. amarus* indicated a greater α-amylase inhibitory potency compared to *M. indica* and *M. koenigii*.

Conclusion: The ethanol extracts of *P. amarus*, *M. indica*, and *M. koenigii* demonstrated notable in vitro α-amylase inhibitory activity, while *P. amarus* showed the highest potency. This higher activity would be mostly due to the distinct phytochemical content of the plant.

Keywords: α-Amylase inhibition, Diabetes mellitus, Medicinal plants

Prevalence, Awareness, and Health Impacts of Polycystic Ovary Syndrome among Female Undergraduates in Non-State Universities in Colombo District, Sri Lanka

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Introduction: To assess the prevalence, level of awareness, lifestyle factors, self-examination practices, and associated health impacts related to Polycystic Ovary Syndrome (PCOS) among female undergraduate students attending non-state universities in the Colombo District.

Objectives: To assess the prevalence, awareness, lifestyle factors, self-examination practices, and health impacts of PCOS among female undergraduate students in non-state universities in Colombo District, Sri Lanka.

Methodology: A cross-sectional study was conducted among 384 female undergraduates aged 18–30 years. Data were collected using a self-administered questionnaire distributed via Google forms. While it was validated through a pilot study. The tool assessed demographic details, awareness, and practices related to PCOS. Each awareness response was categorized into levels such as low, moderate and high. Statistical analyses were performed using SPSS version 24.

Results & Discussion: Approximately 31% of female undergraduates in non-state universities within the Colombo District reported having been diagnosed with PCOS or exhibiting related symptoms. Although 52.8% of participants demonstrated a moderate level of awareness, only 21.6% showed high awareness of the condition, while the remainder lacked adequate knowledge of risk factors and lifestyle modifications. A moderate positive correlation was observed between PCOS diagnosis and family history ($r = 0.420$, $p < 0.001$), as well as between PCOS and type 2 diabetes ($r = 0.395$, $p < 0.001$). A weak but significant correlation between menstrual irregularities and PCOS diagnosis ($r = 0.242$, $p < 0.001$).

Conclusion: Nearly one-third of female undergraduates in non-state universities within the Colombo District experience PCOS-related symptoms, yet overall awareness remains limited. These findings highlight the need for improved education and screening to support early detection and management among young women.

Keywords: Awareness, Polycystic Ovary Syndrome, Prevalence

Evaluation of Antibacterial Properties of Selected Sri Lankan Medicinal Plant Extracts against *Staphylococcus aureus*

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Introduction: Acne vulgaris is a prevalent dermatological condition caused by *Staphylococcus aureus*. Conventional treatments are often associated with adverse effects prompting exploration of alternative therapies for safer and more effective treatment.

Objectives: To evaluate the antibacterial activity of selected Sri Lankan medicinal plant extracts against *S. aureus* using the agar well diffusion method.

Methodology: Six Sri Lankan medicinal plants including, rhizomes of *Curcuma longa*, stem of *Rubia cordifolia*, leaves of *Azadirachta indica*, pure oil of *Santalum album*, fruit peels of *Punica granatum*, and inner bark of *Cinnamomum verum* were dried and powdered samples of each material (15–20 g) were refluxed using ethanol. The crude extracts were concentrated under reduced pressure. A double dilution series of 200, 100, 50, and 25 mg/mL was prepared for each extract using distilled water. Antibacterial activity against S. aureus was assessed using the agar well diffusion assay, with ampicillin serving as the positive control. A one-way ANOVA was conducted at a significant level of P = 0.05.

Results & Discussion: *S. album*, *P. granatum*, and *A. indica* exhibited antimicrobial activity against *S. aureus*, while the other three plant extracts, *C. longa*, *R. cordifolia*, and *C. verum* did not exhibit activity at the tested concentrations. The highest antimicrobial activity was exhibited by the pure oil of S. album, followed by *P. granatum* fruit peels and *A. indica* leaves, with ZOI values of 25.3±1.10 mm, 22.8±1.76 mm, and 16.2±2.36 mm at 200 mg/mL, respectively. The one-way ANOVA demonstrated that the group means differed significantly (P = 0.001) at the 0.05 significance level, revealing that different concentrations produced significantly different antimicrobial effects.

Conclusion: *S. album* pure oil and ethanolic extracts of *P. granatum* fruit peels, and *A. indica* leaves possess notable antibacterial activity against *S. aureus* when compared to the other three extracts used. Sri Lanka's diverse medicinal flora offers natural compounds with potential antibacterial activity and represents a novel, safer approach to acne vulgaris treatment.

Keywords: Acne vulgaris, Antibacterial activity, Herbal extracts, *Staphylococcus aureus*

Larvicidal Activity of *Cinnamomum verum* L. Presl Against Secondary Dengue Vector, *Aedes albopictus*

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Introduction: Dengue fever is an escalating public health issue, with *Aedes albopictus* identified as a newly emergent secondary vector. Synthetic pesticides remain the dominant method of control; however, resistance and environmental dangers demonstrate the need for plant-based alternatives.

Objectives: To investigate the larvicidal activity of the leaves of *Cinnamomum verum* L. Presl against the larvae of *Aedes albopictus*.

Methodology: Essential oil from *C. verum* was extracted via hydro-distillation from dried leaf powder and subsequently diluted in 0.5% DMSO to create concentrations ranging from 31.25 to 1000 μg/mL. Early fourth instar larvae were subjected to test solutions, with 25 larvae per replicate and three replicates were conducted. Mortality was assessed at 24 and 48 hours, and LC_{50} and LC_{90} values were calculated. 100% DMSO was used as the positive control. Statistical analysis was performed using one-way ANOVA (SPSS V25.0) with significance set at $p \leq 0.05$.

Results & Discussion: The essential oil extracted from *C. verum* leaves exhibited potent larvicidal activity against *Aedes albopictus* larvae, with 95% mean mortality observed at the highest concentration after 24 hours. Complete mortality was achieved at concentrations $\geq$ 250 μg/mL within 48 hours across all trials. The lowest concentration (31.25 μg/mL) showed 93%–100% mortality after 48 hours. The LC_{50} value was 31.25 μg/mL for both 24 and 48 hours, while LC_{90} values were 250 μg/mL (24 h) and 31.25 μg/mL (48 h). Statistical analysis showed no significant differences ($p > 0.05$) in mortality compared to the 100% DMSO control.

Conclusion: *C. verum* leaf essential oil demonstrated potent, concentration-dependent larvicidal effects against *A. albopictus*, highlighting its potential as an eco-friendly alternative to synthetic insecticides. However, this study was limited by not testing concentrations below 31.25 μg/mL, which may have revealed lower effective thresholds.

Keywords: *Aedes albopictus*, *Cinnamomum verum*, Dengue vector control, Larvicidal activity

Serum hTERT mRNA as a Potential Non-invasive Biomarker for NASH-HCC: A Sri Lankan Perspective

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Introduction: Liver cancer is the sixth most common cancer and the third leading cause of cancer-related mortality worldwide. Most recent data shows liver cancer is ranked 20th in 5-years prevalence in Sri Lanka. Hepatocellular carcinoma (HCC) is the most common type of primary liver cancer. Non-alcoholic steatohepatitis (NASH) is one of the emerging risk factors of HCC, with increasing rates in both African and Asian regions. Human telomerase reverse transcriptase (hTERT) is one of the key driver genes that influence HCC. hTERT catalyzes the insertion of the short DNA sequence, such as "TTAGGG", to newly replicated telomeres during normal cell division. However, hTERT overexpression can prevent cells from undergoing traditional apoptosis by maintaining the hepatocyte's telomere length, thereby promoting conditions such as hepatocarcinogenesis.

Objectives: This study aims to investigate any possible correlation between serum hTERT mRNA expression levels and traditional liver injury markers such as aspartate aminotransferase (AST), alanine aminotransferase (ALT), and alpha-fetoprotein (AFP).

Methodology: We used the real-time quantitative PCR (qPCR) technique to quantify the expression levels of hTERT mRNA.

Results & Discussion: This study comprised (N=21) participants: (n=7 NASH-HCC test subjects), (n=7 cirrhotic age, BMI, and gender matched controls), and (n=7 healthy individuals) who were referred to North Colombo Teaching Hospital, Ragama, Sri Lanka. The participants cover both the Sinhalese, Tamil, and Muslim populations. The mean (± SD) hTERT mRNA expression level in the NASH-HCC cohort was 9.11 ± 8.44. Further, the hTERT expression level showed a significant correlation ($p < 0.05$) with the serum ALT level.

Conclusion: This reported significant correlation of hTERT and ALT suggests the potential of serum hTERT mRNA as a non-invasive biomarker for liver injury.

Keywords: Hepatocellular carcinoma, Human telomerase reverse transcriptase, Non-alcoholic steatohepatitis

Comparative Pre-compression Study of Cetirizine Hydrochloride Granules Prepared with Selected Semisynthetic Polymers

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Introduction: Cetirizine hydrochloride is an antihistamine exhibits limited bioavailability due to its poor upper gastrointestinal absorption and short half-life. Formulation of cetirizine granules facilitates improved flow properties, drug uniformity and compressibility.

Objectives: This study focused on formulating and evaluating cetirizine hydrochloride granules using wet granulation technique with various hydrophilic polymers.

Methodology: The granules were formulated by blending cetirizine hydrochloride active pharmaceutical ingredient with various polymers such as hydroxyethyl cellulose (HEC), hydroxypropyl methyl cellulose K15 (HPMC K15), hydroxypropyl methyl cellulose K4 (HPMC K4), and sodium carboxymethylcellulose (CMC-Na) separately. Microcrystalline cellulose was used as the diluent while starch paste was used as the primary granulating agent. Physical assessments were conducted for colour, odour, and texture of the granules. The formulated granules (with 1-2% w/w moisture) were subjected to pre-compression evaluations.

Results & Discussion: All the granule batches formulated with different polymers were white to off-white in colour, odourless, free-flowing, and coarse in texture. The results demonstrated that HEC-based granules exhibited superior performance with a bulk density of 0.4936±0.005 g/cm3, tapped density of 0.5419±0.006 g/cm3, Carr's Index of 8.86 ± 0.22%, Hausner's ratio of 1.10 ± 0.02, angle of repose of 32.09 ± 0.16° indicating excellent flow characteristics. HPMC K4 demonstrated comparable performance with a bulk density of 0.2906±0.003 g/cm3, tapped density of 0.3378±0.004 g/cm3, Carr's Index of 13.95±0.05 and Hausner's ratio of 1.17±0.03, categorizing it as "good flow properties". In contrast, HPMC K15 and CMC-Na granules presented poorer performance, demonstrating their limited suitability for direct compression.

Conclusion: The wet granulation method was effective in manufacturing granules using the tested hydrophilic polymers. Granules with HPMC K4 and HEC demonstrated optimal flow properties and compressibility. This suggests that incorporating these granules in cetirizine tablet formulation may improve process efficiency and reduce potential production defects.

Keywords: Cetirizine hydrochloride, Polymers, Pre-compression evaluation, Wet granulation

Extraction and Perfume Formulation from Essential Oil of *Pimpinella anisum* L. Seeds

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Introduction: Fragrances derived from natural sources are widely used in the perfume industry to develop smelling perfumes. Majority of the flavors are derived from natural sources from extraction or chemical synthesis. *Pimpinella anisum* L. belongs to Apiaceae family and is commonly found in Southeast Asia. *P. anisum* is used as a fragrance in the cosmetic industry and aromatherapy.

Objectives: The study was conducted to extract the fragrance present in *P. anisum* seeds and to formulate the perfume.

Methodology: Fresh dry seeds of *P. anisum* (120 g) were placed in a round bottom flask containing 100 mL of distilled water and steam distillation was carried out nearly three hours to extract the essential oil. The extracted essential oil and water (20 mL) was transferred to a separatory funnel and was extracted three times with 20 mL of chloroform. The combined chloroform layers were evaporated to dryness using a rotary evaporator to obtain the essential oil. The formulation of the perfume was conducted by adding essential oil (5 mL), alcohol (95% V/V, 2.5 mL) and glycerin (2.5 mL) and was poured into a glass bottle and the odor of the developed perfume was monitored.

Results & Discussion: The total of 5 ml of pure essential oil was obtained by solvent extraction method per 120 g of dry seeds of *P. anisum*. The extracted essential oil was white in color and has a cumin fragrance.

Conclusion: The essential oil extracted from the seeds of *P. anisum* is soluble in chloroform and susceptible to heat. Further studies are needed to conduct the durability of the developed perfume and the composition analysis of the extracted essential oil.

Keywords: Extraction, Perfume, *Pimpinella anisum*, Steam distillation

Placental Shape Variation in Relation to Maternal Weight: A Preliminary Observational Study in Singleton Pregnancies, Colombo South Teaching Hospital, Sri Lanka

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Introduction: Placental morphology serves as a valuable indicator of both maternal and foetal health outcomes.

Objectives: To investigate variations in placental shape in relation to maternal weight at Colombo South Teaching Hospital, Sri Lanka.

Methodology: A total of 30 clinically healthy pregnant women, aged between 20 and 40 years with singleton pregnancies completed 38 weeks of gestation, were recruited at the time of admission at Colombo South Teaching Hospital. Based on body mass index (BMI), 20 participants were classified as normal weight (BMI 18.5–24.9 kg/m^2), while 10 were categorized as overweight (BMI>25 kg/m^2). Exclusion criteria included pre-existing medical conditions such as diabetes mellitus, autoimmune diseases, hypertension, multiple gestations and pregnancy complications. Maternal weight in the first trimester and at the third trimester (prior to delivery), maternal height, placental weight, and neonatal weight were recorded. Placental shape was assessed visually post-delivery and categorized as round, oval, or irregular.

Results & Discussion: In the normal weight group, 55% of placentas were round, 35% oval, and 10% irregular. In contrast, among overweight mothers, 40% of placentas were round, 10% oval, and 50% irregular. These findings suggest a possible trend toward increased irregular placental shapes among overweight mothers compared to those with normal weight with a statistically significance level of $p<0.05$.

Conclusion: This variation may reflect underlying physiological alterations linked to maternal weight, which could influence placental function. This preliminary study with a limited sample size highlights the importance of monitoring maternal weight during pregnancy as placental morphology assessment serves as a useful, non-invasive indicator for identifying pregnancies that are at risk.

Keywords: Maternal weight, Placental shape, Singleton pregnancies

Assessment of Knowledge and Attributes of Undergraduate Students on the Prevalence of Dengue During Heat Waves in Colombo District, Sri Lanka

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Introduction: In Sri Lanka, dengue fever is a major public health concern with increasing incidence in urban areas like the Colombo District. The frequent heat waves and rising temperatures have raised questions about their potential impact on dengue transmission.

Objectives: To assess the knowledge, awareness, and attitudes of undergraduate students regarding dengue prevalence during heat waves in Colombo.

Methodology: A descriptive cross-sectional study was conducted over four months among undergraduate students aged 18–30 years from eleven universities (three state and nine non-state) in the Colombo District. The ethical approval was obtained from the ethics review committee of CINEC campus Malabe and 427 participants were selected using a stratified sampling method. Data were collected via a self-administered online questionnaire available in Sinhala, Tamil, and English, covering demographics, knowledge, attitudes, and self-examination practices. Descriptive statistics were used for analysis using SPSS version 30.

Results & Discussion: The majority (98%) of participants were aware of dengue, with 367 (86%) identifying it as a viral disease. While 378 (88.6%) recognized mosquito bites as the transmission route, 129 (30.2%) mistakenly believed contaminated water could also spread dengue. Only 254 (59.4%) correctly identified Aedes aegypti as the vector. Regarding heat waves, 374 (87.7%) had been infected, yet only 148 (34.7%) believed they influenced dengue spread, while 225 (52.6%) were unsure. Social media 184 (43.2%) and news outlets 128 (30.5%) were the primary information sources. Most participants, 387 (90.6%) acknowledged preventive methods such as covering water containers, and 320 (75%) participated in health education programs such as workshops.

Conclusion: Undergraduate students in Colombo demonstrated high awareness of dengue, but notable gaps remain in knowledge of transmission routes, the role of *Aedes aegypti*, and the potential impact of heat waves. Strengthening targeted health education and integrating climate-related risk communication into awareness programs are essential to enhance preparedness and prevention in the context of rising temperatures.

Keywords: Aedes aegypti, Dengue, Heat waves, Prevalence

Knowledge and Practices Related to Betel Quid Consumption and Awareness of Oral Health and Salivary Amylase Enzyme among Estate Sector Workers in Galle and Kalutara Districts, Sri Lanka

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Introduction: Betel quid chewing is common in Sri Lanka, especially in estate communities, yet awareness of its effects on salivary components like amylase remains limited.

Objectives: To investigate the prevalence, behavioral patterns of BQ consumption, the knowledge level, practices and awareness associated with salivary amylase and oral health among estate workers in the Galle, Kalutara districts.

Methodology: A cross-sectional survey was conducted among 80 adults, using convenience sampling, aged 21-75 years, from Kalutara, Galle districts by an interviewer administered structured questionnaire. These districts were selected as their high concentration of estate populations. Participants were divided into two groups: BQ consumers (n=40) and non-consumers (n=40).

Results & Discussion: Most of the participants (93.7%) reported they had no prior knowledge of salivary amylase, and over half (53.9%) lacked knowledge of the link between BQ chewing and oral cancer. BQ chewing was most common among adults aged 36–50 years (45%), with 70% chewing daily and 80% consuming more than two quids per day. Over half (55%) had used BQ for more than six years. Habitual use (82.5%) was the main reason for consumption. Oral health issues were reported by 92.5% of BQ users, including gum disease (35%), tooth decay (20%), dry mouth (10%). 68.8% were aware of oral health risks linked to BQ, and 61.3% knew about oral cancer screening. BQ use showed a moderate positive correlation with oral health problems (r=0.512, p<0.001). Educational level positively correlated with awareness of oral cancer risks (r=0.231, p=0.039).

Conclusion: Long-term BQ consumption among estate workers, but low awareness about oral health risks and less knowledge about salivary amylase. Findings highlight the need for health education, oral screening, and preventive strategies in estate communities.

Keywords: Betel Quid chewing, Estate sector workers, Oral health, Salivary amylase

Evaluation of Antibacterial Activity of *Bridelia retusa* (L.) A. Juss Leaves

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Introduction: The rise of microbial resistance to antibiotics highlights the need for safe, affordable, and accessible plant-based therapies.

Objectives: To investigate the antibacterial activity of the different extracts of *Bridelia retusa* (L.) A. Juss (Family: Phyllanthaceae) leaves.

Methodology: The methanolic and ethanolic extracts of *B. retusa* leaves were made by maceration. The aqueous leaf extract was made by refluxing. Antibacterial activity was assessed against sensitive and multidrug-resistant (MDR) strains of *Staphylococcus aureus* and *Pseudomonas aeruginosa* using the agar-well diffusion method in nutrient agar plates at 37°C. Gentamicin (10 μg/disc) antibiotic disks were used as positive controls.

Results & Discussion: The ethanolic leaf extract (6,250–10,000 ppm), showed significantly higher zone of inhibition (ZOI) against *S. aureus* (sensitive), ranging from 19.7±0.6 mm to 25.0±0.0 mm, compared to Gentamicin (19.0±0.0 mm). The methanolic leaf extract at 10,000 ppm showed significantly higher ($p<0.05$) ZOI as 19.3±6.2 mm, than that of Gentamicin. The aqueous leaf extract at 50,000 and 10,000 ppm showed significantly higher ($p<0.05$) ZOI as 19.3±0.6 mm and 20.0±0.0 mm against *S. aureus* (sensitive), compared to Gentamicin. The methanolic leaf extract (25,000-100000 ppm) and the aqueous leaf extracts at 50,000 and 10,000 ppm also showed notably higher ($p<0.05$) ZOI, ranging from 22.7±2.3 to 27.0±1.0 mm and 19.7±0.6 mm and 21.7±1.2 mm, respectively, against *S. aureus* (MDR) compared to Gentamicin (18.3±0.6 mm). The methanolic leaf extract (25,000 -10000 ppm) and the aqueous leaf extract at 10,000 ppm showed considerably higher ($p<0.05$) ZOI, ranging from 17.3±0.6 mm to 20.7±1.2 mm and 19.7±0.6 mm, respectively, against *P. aeruginosa* (MDR), compared to Gentamicin (ZOI=16.3±0.6 mm).

Conclusion: The methanolic leaf extract and the aqueous leaf extract of *B. retusa* at 10,000 ppm exert significantly higher potent ZOI against *S. aureus* (sensitive and MDR) and *P. aeruginosa* (MDR) than the positive controls, indicating a potential on developing antimicrobial active agent/s.

Keywords: Antibacterial, *Bridelia retusa*, Multidrug-resistant, Sensitive, Zone of inhibition

Insulin Resistance and its Association with Cardiometabolic Risk Factors in Apparently Healthy Obese Adults; A Cross-sectional Study

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Introduction: Obesity has emerged as a worldwide public health challenge and induces Insulin Resistance (IR), which is the major contributing factor for the development of Cardiometabolic Risk Factors (CRFs).

Objectives: To evaluate the relationship between IR and CRFs in apparently healthy obese adults in the Galle district, Sri Lanka.

Methodology: A total number of 210 apparently healthy obese adults aged 18–60 years was enrolled for the present community-based descriptive cross-sectional study. Individuals with any kind of disease were excluded from this study. Sociodemographic and anthropometric parameters were collected. Body Mass Index (BMI) was calculated. The Fasting Plasma Glucose (FPG) concentration, serum lipid profile, and serum insulin concentration were determined. Insulin resistance was calculated using the Homeostasis Model Assessment of Insulin Resistance (HOMA-IR). CRFs were defined using the cut-off values of different parameters. SPSS V 25.0 was used in the statistical evaluation.

Results & Discussion: The median BMI was 27.4 (26.20–29.55) kg/m^2. Strong positive relationships were observed between HOMA-IR and BMI (r=0.147, p=0.034), FPG (r=0.426, p<0.001), triglyceride (r=0.318, p<0.001), and waist circumference (WC) (r=0.222, p=0.001). After adjusting for potential confounders, increases in BMI, FPG, triglyceride, and WC were significantly associated with increases in IR. FPG (p=0.004) and triglyceride (p=0.025) showed significant predictive performance, with an area under the curve of 0.900 (95% CI: 0.830–0.970; p=0.001) and 0.814 (95% CI: 0.654–0.973; p=0.009), respectively. The optimal cut-off values for triglyceride and FPG were 1.455 mmol/L and 4.295 mmol/L, respectively, to identify IR in apparently healthy obese adults.

Conclusion: The optimal cut-off values of triglyceride and FPG could be used for early identification of IR in apparently healthy obese individuals. Early identification, followed by appropriate timely intervention, has the potential to reduce the risk of developing associated CRFs.

Keywords: Apparently healthy, Cardiometabolic risk factors, Insulin resistance, Obesity

The Awareness of Young-Onset Type 2 Diabetes Mellitus, its Risk Factors, Complications, and Preventive Measures among Adults; A Cross-sectional Study in the Colombo District

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Introduction: Young-onset type 2 diabetes mellitus (T2DM) has become an emerging global health concern, particularly in developing countries like Sri Lanka.

Objectives: To assess the awareness of young-onset T2DM, its risk factors, complications, and preventive measures among community-dwelling young adults in the Colombo district, Sri Lanka.

Methodology: A community-based cross-sectional study was conducted, enrolling 400 randomly selected individuals in the Colombo district who were between 19–40 years old. Data related to the study were collected through a semi-structured, interviewer-administered questionnaire.

Results & Discussion: The 400 participants interviewed included 203 males and 197 females, with a mean (SD) age of 26.3 (6.1) years for males and 26.5 (5.2) years for females. Educational levels varied, with 10% not schooled, 15% primary, 35% secondary, 30% certificate/diploma, 8% graduate, 2% postgraduate, and <1% other, with higher education associated with greater awareness ($p<0.05$) of young-onset T2DM. Among the participants, 18.3% (n=73) had young-onset T2DM, while only 22% (n=88) had undergone T2DM screening. Most participants (43.8%, n=175) identified frequent urination as a symptom of T2DM, while 24.8% (n=99) were unaware of any symptoms. Unhealthy diet (48.3%, n=193) was the most aware risk factor, secondary to family history (57.8%, n=231). Kidney damage was the most identified complication (41.8%, n=167), while adhering to a healthy diet was the most frequently cited preventive measure (50%, n=200). A high percentage (60%) were unaware of the importance of regular health checkups in managing young-onset T2DM. Nearly half of the participants (48%, n=192) reported the absence of sufficient education and awareness programs among young adults on young-onset T2DM.

Conclusion: The study findings emphasize the need for targeted health education initiatives aimed at improving knowledge and awareness, promoting early detection strategies, and implementing preventive measures for young-onset T2DM, to help reduce the global burden of this condition.

Keywords: Awareness, Complications, Diabetes mellitus, Risk factors, Symptoms

Determination of Prevalence of Maturity Onset Diabetes of the Young Suspects in Sri Lanka

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Introduction: Maturity onset diabetes of the young (MODY) is a monogenic form of diabetes that affects young people (<30 years). It accounts for 1–5% of all diabetic cases worldwide and is often misdiagnosed due to the overlapping features of type 1 or type 2 diabetes. Presently, there are 14 known subtypes of MODY. In Sri Lanka, MODY remains under-researched despite the growing burden of diabetes.

Objectives: To determine the prevalence of MODY suspects in the Sri Lankan population.

Methodology: A structured online questionnaire was administered to individuals aged 15 to 30 years, including school and university students, and employed youth in Sri Lanka. Basic demographic, medical and family history were collected. Based on a predefined inclusion and exclusion criteria, suspected MODY individuals were selected based on their responses. Ethical clearance was obtained from the Ethics Review Committee of CINEC Campus. Data was analyzed using SPSS version 27.

Results & Discussion: A total of 398 participant questionnaire responses were collected and analyzed. Among them, 15 (3.77%) were identified as MODY suspects. The suspected MODY cohort comprised 4 (26.7%) males and 11 (73.3%) females with a mean age of 24.47 ± 1.959. According to the BMI calculations, 10 (66.7%) were of healthy weight, 3 (20%) were overweight, 2 (13.3%) were underweight and none were obese. Notably, 2 of the 15 suspected MODY patients had a confirmed diabetes mellitus. Findings suggest a portion of the Sri Lankan youth may be either undiagnosed or misdiagnosed for MODY.

Conclusion: The study identified prevalence of 3.77% suspected MODY cases in Sri Lanka highlighting the need for greater clinical awareness and early identification for better treatment decisions, with improved long term health outcomes.

Keywords: Diabetes mellitus, Maturity onset diabetes of the young, Prevalence, Sri Lanka

Comparative Analysis of Sun Protective Factor Potential in Aqueous, Hexane, and Ethanol Extracts of *Zingiber zerumbet* (L.) Smith

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Introduction: *Zingiber zerumbet* (L.) Smith, from the Zingiberaceae family, is traditionally used for skin ailments and contains compounds with potential UV-protective properties. Evaluating the influence of extraction solvents on its UV-protective potential is essential for optimizing its use in natural sunscreen formulations.

Objectives: To assess how different solvents affect the sun protection ability of *Z. zerumbet* rhizome extracts as natural sunscreen agents.

Methodology: The dried, powdered *Z. zerumbet* rhizomes were extracted using hexane, ethanol, and water through maceration. The resulting extracts were concentrated and stored at -20 °C. Test solutions (0.05, 0.10, 0.15, 0.20, 0.25, 0.50, and 1.00 mg/mL) were prepared. SPF values were calculated using the Mansur equation ($SPF = CF \times \sum [EE(\lambda) \times I(\lambda) \times Abs(\lambda)]$) from 290 to 320 nm range using a UV–Visible spectrophotometer. Sun protective potential of extracts was compared using one-way ANOVA and Tukey's post hoc test.

Results & Discussion: The aqueous extract exhibited the highest mean SPF value of 22.70 ± 0.02, significantly exceeding the hexane (11.83 ± 1.55) and ethanol (5.62 ± 2.07) extracts. Statistical analysis showed significant differences between the aqueous extract and both ethanol and hexane extracts ($p < 0.05$), while no significant difference was observed between the hexane and ethanol extracts ($p > 0.05$). At a concentration of 1.00 mg/mL, the aqueous extract achieved an SPF of 22.82, which was notably higher than hexane and ethanol extracts.

Conclusion: The aqueous extract of *Z. zerumbet* demonstrated the strongest and most consistent SPF at 1 mg/mL, indicating its high potential for natural sun-protective formulations.

Keywords: Natural sunscreen, Photoprotection, Plant extracts, Sun protection factor, *Zingiber zerumbet* (L.) Smith

Evaluation of Toxicity of Drinking Water in Plastic Bottles Stored at Different Environmental Conditions using Zebrafish Embryo Model

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Introduction: Plastic water bottles may leach harmful substances under certain conditions, posing health risks, thus requiring toxicity assessment for consumer safety.

Objectives: To evaluate the potential toxicity of commercially available bottled drinking water stored under different environmental conditions using the Zebrafish (*Danio rerio*) embryo toxicity test, in accordance with OECD guideline 236 with some modifications.

Methodology: Commercially available bottled water samples were stored under four different environmental conditions i.e. room temperature, refrigerator, dark cupboard, and exposure to direct sunlight, for a defined period (24 hours and 7 Days). Zebrafish embryos were exposed to each water sample from 0 to 6 hours post-fertilization. Distilled water served as a negative control, while 50% ethanol was used as a positive control.

Results & Discussion: Water samples stored in the refrigerator exhibited the highest toxicity, with increased mortality and developmental deformities among Zebrafish embryos. Samples stored at room temperature demonstrated the lowest toxicity (32% for 24 hours and 40% for 7 Days), with minimal adverse effects observed. Samples exposed to sunlight and stored in dark cupboards showed intermediate levels of toxicity. These findings suggest that low temperatures may influence the leaching of harmful substances from plastic bottles into the water (60% for 24 hours and 57% for 7 Days).

Conclusion: Our study underscores the importance of storage conditions in determining the safety of bottled drinking water. Refrigeration, surprisingly, may increase toxicity risk due to chemical leaching.

Keywords: *Danio rerio*, Drinking water, Zebrafish

Formulation and Development of Polyherbal Antioxidant Syrup

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Introduction: Sri Lankan traditional medicine extensively utilizes various medicinal plants for their therapeutic properties, including antioxidant potential.

Objectives: This study develops a stable polyherbal antioxidant syrup incorporating *Terminalia chebula* Retz. ("Aralu"), *Pedalium murex* L. ("Gokatu"), *Cassia fistula* L. ("Ehela"), *Ouret lanata* (L.) Kuntze ("Polpala"), and *Tragia involucrata* L. ("Wel Kahabiliya"), based on their previously observed antioxidant activity.

Methodology: Each plant extracts (80% isopropyl alcoholic) were prepared by maceration and combined to make polyherbal syrup. Different syrup bases were formulated using varying concentrations of sucrose, distilled water, citric acid, and sodium benzoate. Stability testing of the base syrups was conducted under three storage conditions: refrigerated (4 °C), room temperature (25 °C), and elevated temperature (40 °C). The most stable base was selected for incorporating the plant extracts to develop four polyherbal syrup formulations (F_1–F_4). The antioxidant activity of each formulation was assessed using the DPPH assay with triplicates and mean value was taken to find IC_{50} value. The toxicity was evaluated using the brine shrimp lethality assay.

Results & Discussion: Among the developed formulations, F_4 demonstrated the highest antioxidant potential, with the lowest IC_{50} value (22.89 µg/mL). This was 15.44 µg/mL for ascorbic acid. The F_4 also exhibited a clear appearance with no signs of phase separation or precipitation during stability testing. The brine shrimp lethality assay revealed a favorable safety profile, with an LC_{50} value of 707.95 µg/mL.

Conclusion: A stable and effective polyherbal antioxidant syrup was developed incorporating traditionally used medicinal plants. The formulation exhibited significant antioxidant activity and low toxicity for future clinical applications as a natural health supplement.

Keywords: Antioxidant, DPPH, Polyherbal, Syrup

Association between Maternal Anthropometry and Gestational Diabetes Mellitus among Sri Lankan Pregnant Women: A Preliminary Study

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Introduction: Gestational diabetes mellitus (GDM) is a significant health concern among pregnant women in Sri Lanka. Early identification of risk factors such as maternal anthropometry is essential to prevent adverse maternal and fetal outcomes.

Objectives: The study aimed to evaluate the differences in maternal anthropometric characteristics, such as body mass index (BMI) and weight gain, between women with and without GDM to better understand potential risk indicators.

Methodology: Ethical clearance was obtained from the Ethical Review Committee of CINEC Campus, Sri Lanka, and the Institutional Ethical Review Committee of the Colombo South Teaching Hospital Kalubowila. Written informed consent was obtained from all participants. Pregnant women (n=30) aged between 25-40 years were recruited for the study during delivery of their babies at Colombo South Teaching Hospital. Pregnant women were divided into two groups as 15 GDM mothers and 15 non-GDM mothers. A structured questionnaire was used for the collection of anthropometric data such as pre-pregnant BMI, weight gain, pregnancy complications and intake of dietary supplements. Obtained results were analyzed using SPSS version 30.0.

Results & Discussion: GDM group demonstrated a significantly higher mean BMI compared to the non-GDM group (mean BMI: GDM=25.4 ± 3.77 kg/m^2 vs. non-GDM=22.74 ± 4.21 kg/m^2, p<0.05). Pre-pregnancy weight was significantly greater in the GDM group (62.5 ± 8.7 kg) compared to the non-GDM group (55.2 ± 8.2 kg, p=0.005). Moreover, there was a significant positive correlation between pre-pregnancy weight and GDM status (r = 0.42, p = 0.008).

Conclusion: This study found that mothers with gestational diabetes had significantly higher pre-pregnancy BMI and weight. A positive correlation between initial weight and GDM status suggests maternal anthropometry plays a role in GDM risk. These findings emphasize the need for early screening and targeted interventions focused on weight management before and during pregnancy to avoid adverse consequences.

Keywords: Anthropometry, Body mass index, Gestational diabetes mellitus

Evaluation of Antibacterial Properties of the Stem Bark of *Bridelia retusa* (L.) A. Juss.

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Introduction: The emergence of antibiotic-resistant bacterial strains has intensified the global search for alternative therapeutic agents derived from medicinal plants. *Bridelia retusa* (L.) A. Juss (Family: Phyllanthaceae), locally known as "Path Kela", has been traditionally used in indigenous medicine to treat microbial infections.

Objectives: To investigate the antibacterial activity of *B. retusa* stem bark extracts.

Methodology: The methanolic and ethanolic crude extracts of *B. retusa* stem bark were made by maceration. The crude aqueous stem bark extract was made by refluxing. Antibacterial activity was assessed against sensitive and multidrug-resistant (MDR) strains of *Staphylococcus aureus*, *Pseudomonas aeruginosa*, and *Escherichia coli* using the agar-well diffusion method. Gentamicin and Ciprofloxacin antibiotic disks were used as positive controls. SPSS V 25.0 was used to analyze the collected data.

Results & Discussion: The methanolic and ethanolic stem bark extracts (25,000–100,000 ppm) showed significantly higher ($p<0.05$) Zone of inhibition (ZOI) against *S. aureus* (sensitive), ranging from 22.7±2.3 mm to 27.0±1.0 mm, and from 21.7±0.6 to 27.0±0.0 mm respectively, compared to Gentamicin (19.0±0.0 mm). The aqueous stem bark extract at 10,000 ppm showed significantly higher ZOI against *S. aureus* (sensitive) as 19.3±0.6 mm, than that of Gentamicin. The methanolic stem bark extract at 100,000 ppm showed significantly higher ($p<0.05$) ZOI against *S. aureus* (MDR) as 21.3±0.6 mm, compared to Gentamicin (18.3±0.6 mm) and the extract at 50,000 ppm showed non-significant difference of ZOI as 18.3±0.6 mm compared to Gentamicin. The methanolic, ethanolic, and aqueous stem bark extracts of *B. retusa* (6,250–100,000 ppm) did not show significantly higher or non-significant ZOI against both sensitive and MDR *P. aeruginosa* and *E. coli* compared to positive controls.

Conclusion: The methanolic stem bark extract of *B. retusa* at the concentration of 50,000 and 100,000 ppm exert potent ZOI against both sensitive and MDR *S. aureus*.

Keywords: Antibacterial, *Bridelia retusa*, Multidrug-resistant, Sensitive, Zone of inhibition

Risk Factors and Diagnostic Approaches in Uterine Fibroids: A Systematic Review

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Introduction: Uterine leiomyoma or Uterine Fibroids (UFs) are benign tumors arising in the smooth muscles of the uterus. They are also known as uterine leiomyomas or myomas. They are the most common benign tumors affecting women during their reproductive years, often presenting with symptoms such as abnormal uterine bleeding, pelvic pain and infertility.

Objectives: This review was conducted to evaluate the original research data on risk factors associated with UF and the methods used for the diagnosis of UF.

Methods & Analysis: A literature review was conducted following PRISMA guidelines. Under the keyword "leiomyoma", freely accessible data from the PubMed database, published within the past 10 years, were filtered. A total of 104 articles were retrieved for analysis. Evaluation of the findings suggests that the risk of UFs increases with age and is influenced by multiple risk factors, including demographic characteristics, reproductive history, hormonal influence, lifestyle factors, and family history. Conversely, higher consumption of fruits and vegetables, as well as maintaining a healthy body mass index (BMI), is associated with a reduced risk of UFs. Diagnostic tests found in the selected studies include imaging techniques (ultrasound, magnetic resonance imaging (MRI), laboratory investigations, clinical evaluation, hysteroscopy, and endometrial biopsy for accurate diagnosis of UFs. Furthermore, NAV3, a tumor suppressor gene, was found to be significantly downregulated in uterine leiomyoma tissues and cells compared to normal myometrium. Treatment with the GnRH analogue leuprolide acetate increases NAV3 expression, suggesting that NAV3 may play a role in hormone-independent regulation of leiomyomas. Neurotrimin (NTM), a cell adhesion molecule, is elevated in uterine fibroids and is upregulated by estrogen and progesterone, while ulipristal acetate (UPA) significantly reduces its expression. This indicates that NTM may play a role in fibroid pathology and could serve as a biomarker and therapeutic target in hormone-dependent uterine diseases.

Conclusion: UFs are associated with modifiable and non-modifiable risk factors, and novel diagnostic approaches are also being explored.

Keywords: Diagnosis, Risk factors, Uterine fibroids

Integrated Profiling of Pathogenic Bacterial Communities in the *Rosa* spp. and *In Vitro* Antibiofilm and Phytochemical activity of *Adenanthera Pavonina* Extracts, Colombo District, Sri Lanka

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Introduction: Biofilm-forming pathogens are increasingly found in plant-associated environments, posing public health risks.

Objectives: To isolate and identify human pathogenic bacteria from the phyllo-sphere and rhizosphere of *Rosa* spp., and evaluate the antibiofilm and phytochemical activity of aqueous and methanolic *Adenanthera pavonina* leaf extracts against the selected isolates of *Rosa* spp.

Methodology: Samples were collected from three urban and semi-urban sites in the Colombo District. Bacteria were isolated using serial dilution and cultured on MacConkey, EMB, and nutrient agar media. Identification was based on colony morphology, Gram staining, and a series of biochemical tests (IMViC, TSI, catalase, oxidase). Crude extracts were obtained via maceration in methanol and hot water. Biofilm biomass inhibition was assessed using the microtiter plate crystal violet assay and absorbance was measured at 595 nm, and percentage inhibition was calculated. Phytochemical analysis was performed. Statistical analysis was conducted using two-way ANOVA (p<0.05) via SPSS (24.0).

Results & Discussion: Both phyllo-sphere and rhizosphere of *Rosa* spp. harbored human-associated pathogens including *E. coli* (28.9%), *Klebsiella* spp. (23.7%), *Enterobacter* spp. (18.4%), *Serratia* spp. (15.8%), and *Bacillus* spp. (13.2%) with *Klebsiella* spp. (23.7%) and *E. coli* being predominant. Methanolic *A. pavonina* extracts showed superior antibiofilm activity, inhibiting biofilm biomass up to 61.2% against *Klebsiella* spp., followed by *Serratia* spp. (57.4%) and *E. coli* (53.6%). Aqueous extracts were less potent but still effective, achieving inhibition rates between 45–55%. Statistically significant differences (p=0.0025) were observed between treated and control groups. Biofilm disruption is likely due to polyphenolic compounds which identified flavonoids, tannins, alkaloids, and phenols interfering with cell attachment and matrix synthesis.

Conclusion: Microbial diversity on *Rosa* spp. and showcases *A. pavonina* extracts' antimicrobial potential, paving the way for future research on clinical applications.

Keywords: *Adenanthera pavonina*, Antibiofilm, Phyllosphere, Rhizosphere, *Rosa* spp.

Attitudes, Knowledge, and Practices Regarding Antibiotic Resistance Among Undergraduate Students in Private Higher Educational Institutes in Colombo District Sri Lanka

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Introduction: Antibiotic resistance is a global health threat driven by public misuse, viral-treatment misconceptions leading to treatment failures, prolonged illness, and increased complications. Understanding undergraduates' knowledge and behavior remains under addressed.

Objectives: To assess the knowledge, attitudes, and practices regarding antibiotic use and resistance among undergraduates in private universities and higher educational institutions in Colombo District, Sri Lanka.

Methodology: A descriptive cross-sectional study was conducted among 384 students of 23 private higher educational institutes under different faculties using stratified random sampling. Data were collected through a validated self-administered questionnaire assessing demographic details, antibiotic use behavior, knowledge of resistance, and attitudes. Ethical approval was obtained via ethics committee of CINEC campus, Malabe (ERC/CINEC/2024/013). The analysis was done via Chi-square test and One-way ANOVA The significance was set at $p < 0.05$ and the statistical analysis was done via SPSS 24.0.

Results & Discussion: A 78.9% proportion of students demonstrated knowledge score of 50%, while only 14.6% had knowledge score of > 75% on antibiotic use and resistance. Self-medication was reported by 58.1%, with 42.3% incorrectly believing antibiotics treat viral infections. Chi-square analysis revealed significant difference between academic discipline and knowledge level ($\chi^2 = 12.63$, $p = 0.002$), and between gender and practice behavior in undergraduate population ($\chi^2 = 4.31$, $p = 0.038$). One-way ANOVA test showed significantly higher knowledge scores > 75% among students in health-related faculties. Students expressed positive attitudes toward appropriate antibiotic use, but practices were inconsistent, indicating a critical gap between awareness and behavior.

Conclusion: Findings highlight specific misconceptions and risky behaviors among undergraduates, emphasizing the urgency to implement discipline-focused educational programs to promote responsible antibiotic use and reduce resistance.

Keywords: Antibiotic resistance, Self-medication; Sri Lanka, Undergraduate students

Formulation and Development of Antiaging Cream Incorporating *Tamarindus indica* Seeds and Leaves with Antioxidant Potential

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Introduction: Rising demand for natural anti-ageing cosmetics highlights *Tamarindus indica* as a promising antioxidant source against skin ageing.

Objectives: To formulate and evaluate a stable anti-ageing cream incorporating ethanol extracts of germinating seeds and leaves of *T. indica*, focusing on their antioxidant potential and safety for topical application.

Methodology: Ethanol (80%) extracts of germinating seeds and leaves of *T. indica* were mixed in three different ratios (1:1, 1:2, 2:1) and assessed for antioxidant activity using the DPPH (2,2-diphenyl-1-picrylhydrazyl) free radical scavenging assay. Different cream base formulas (F1–F4) containing water, glycerine, coconut oil, emulsifying wax, and methylparaben were developed and the most active *T. indica* seeds and leaves ratio was incorporated into the most stable formula. The best-performing cream base in terms of organoleptic properties, pH, and homogeneity was selected. Toxicity was evaluated using the Brine Shrimp Lethality Assay. Artificial seawater (brine solution) was used as a negative control.

Results & Discussion: In the results, the ratios of germinating seeds and leaves of *T. indica* in 1:1, 1:2, and 2:1 ratios showed IC_{50} values of 24.55 μg/mL, 47 μg/mL, and 11 μg/mL, respectively. This was 4.61 μg/mL for Ascorbic acid, which served as the positive control. Hence, germinating seeds and leaves of *T. indica* 2:1 ratio were incorporated into the base which was identified as a stable cream base. The final cream showed desirable organoleptic properties and acceptable pH and homogeneity. The toxicity assessment revealed an LC_{50} value of 1000 mg/mL, indicating low toxicity.

Conclusion: The study successfully formulated a stable, natural anti-ageing cream incorporating *T. indica* extracts with promising antioxidant properties and low toxicity, suggesting potential for further development as a commercial cosmetic product.

Keywords: Antioxidant, DPPH, *Tamarindus indica*

Preliminary Assessment of Knowledge, Attitudes and Practices on Sunscreen Cosmetic Products in Undergraduates of Universities and Higher Educational Institutes in Western Province, Sri Lanka

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Introduction: Facial skincare practices, particularly the use of cosmetic products like sunscreen, are gaining popularity among youth. However, Knowledge, Attitudes, and Practices (KAP) concerning sunscreen usage can vary significantly. Inadequate understanding of sun protection and irregular application of sunscreen may lead to harmful skin conditions.

Objectives: This preliminary study aimed to evaluate the knowledge, attitudes, and practices related to sunscreen cosmetic products, among undergraduates in universities and higher educational institutes in the Western Province, Sri Lanka.

Methodology: A structured questionnaire was administered to 100 undergraduates aged between 18–30 years using a convenient sampling method. Ethical clearance was obtained from the Ethics Review Committee at CINEC Campus. The sample included 30 males and 62 females, with the majority (41.30%) in the 22–24 age category and 53% residing in urban areas.

Results & Discussion: Awareness of ultraviolet (UV) rays as harmful sunlight was high (93.47%). However, only 54.34% knew what Sun Protective Factor (SPF) meant, and 42.39% had no idea about the optimal SPF value. Although 52.17% reported using sunscreen, regular use was low, only 11.95% applied it daily. A significant portion (31.52%) never used sunscreen. Sunscreen application habits also varied among the participants. While 33.69% applied sunscreen to the face, neck, and hands, only 29.34% covered all exposed areas, indicating insufficient coverage and potentially reduced effectiveness. Purchase decisions were mainly influenced by price (75%), ingredients (67.39%), brand, expiry date, and perceived benefits (each 64.13%), showing a consumer focus on value and safety. However, sensory and aesthetic factors like smell (33.69%) and packaging (22.82%) were less significant.

Conclusion: The study highlights moderate awareness but poor practices regarding sunscreen use among undergraduates. There is a clear need for educational interventions to improve understanding of sun protection, promote consistent sunscreen usage, and encourage informed product choices for better skincare outcomes.

Keywords: Sunscreen, Sun protective factor

Bioimpedance-Based Visceral Fat Assessment and Metabolic Parameters among Patients with Non-Alcoholic Fatty Liver Disease in a Sri Lankan Outpatient Setting

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Introduction: Non-alcoholic fatty liver disease (NAFLD) has emerged as an increasingly prevalent public health issue, closely linked with visceral fat and metabolic abnormalities.

Objectives: To assess visceral fat content and metabolic parameters among patients with non-alcoholic fatty liver disease in a Sri Lankan outpatient setting.

Methodology: The present cross-sectional study involved 150 patients diagnosed with NAFLD, who were recruited from a medical outpatient clinic in the Colombo district. Participants were selected using a convenience sampling approach, and data was collected through a structured questionnaire. Blood-based biochemical parameters were estimated. Visceral fat content was measured using Bioimpedance, and the values were categorized into two groups; values ranging from 1 to 9 were classified as 'normal', while those between 10 and 30 were labeled as 'high'. All the collected data were analyzed using SPSS V 25.0.

Results & Discussion: Among the study subjects, 48.7% (n=73) were female and 51.3% (n=77) were male. The mean BMI of the study cohort was 26.7±4.4 kg/m^2. Of all, 36% were overweight and 21.3% were obese. Mean systolic and diastolic blood pressure were 124±16 and 74±9 mmHg, respectively. The average alanine aminotransferase, aspartate aminotransferase, and fasting plasma glucose concentration were 75.3±33.7 U/L, 64.1±49.9 U/L, and 147.9±60.2 mg/dL, respectively. Their mean total cholesterol, triglyceride, high-density lipoprotein cholesterol, low-density lipoprotein cholesterol, and very low-density lipoprotein cholesterol levels were 186.5±50.5, 133.9±, 48.9±12.0, 107.5±40.1, and 29.9±25.1 mg/dL, respectively. The prevalence of high visceral fat levels among patients with NAFLD was 70.7%. Significantly ($p = 0.002$), males had a higher prevalence of high visceral fat (63%) than females (43%).

Conclusion: A high prevalence of elevated visceral fat was observed among NAFLD patients, particularly in males, with adverse metabolic parameters. Routine visceral fat assessment may aid in effective risk stratification and management of NAFLD.

Keywords: Metabolic parameters, Non-alcoholic fatty liver disease, Prevalence, Visceral fat

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Impact of Psychological Factors on Customer Continuance Usage Intention for Digital Transformation with Special Reference in Western Province Sri Lanka

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Introduction: The Sri Lankan financial revolution has led to a shift from traditional modes of service provision towards technology platforms. However, most existing studies focus on digital adoption rather than continuance usage. This creates a research gap in understanding the psychological drivers that sustain long-term usage, especially in the Sri Lankan context.

Objectives: The objective of this research is to explore the contribution of psychological factors such as usefulness, trust, satisfaction, and habituation to the continuance intention of consumers using digital financial services in Sri Lanka's Western Province.

Methodology: A deductive approach has been adopted. The data were gathered from 299 respondents using a closed-ended questionnaire. The theoretical framework is based on the Technology Acceptance Model (TAM) and Expectation Confirmation Theory (ECT), which explain user behaviour in digital adoption. The independent variables are Perceived Usefulness, Perceived Ease of Use, Perceived Trust, and Perceived Self-Efficacy, while the dependent variable is Continuance Usage Intention (CUI). Satisfaction acts as a moderating variable. Data were analysed using SPSS, including descriptive statistics, reliability tests (Cronbach's Alpha), correlation analysis, regression analysis, and moderation analysis.

Results & Discussion: Trust, usefulness, and habituation have positive effects on continuance intention, and satisfaction plays a moderating role in these relationships. Among the psychological factors, trust was found to be the most significant predictor. These findings are consistent with the TAM and ECT theoretical models.

Conclusion: Increasing user trust and usability can increase the use of digital services. Banks and other financial institutions need to design easy and secure platforms. Demographic variables and rural/urban differences should be looked into by future studies.

Keywords: Continuance intention, Digital financial service, Psychological variables, Satisfaction, Trust

Identifying and Structuring Key Criteria for Supplier Selection through Factor Analysis in the Apparel Industry in the Colombo District

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Introduction: Selecting the appropriate suppliers is critical for an apparel firm, given that it has implications for costs, quality, brands, and overall organizational performance. It is important to focus on apparel companies in Sri Lanka, as the apparel industry is vital to the country's economy, which is very reliant on the apparel industry. The thesis offers deeper insight into how supplier selection criteria interrelate and collectively impact supplier selection decisions.

Objectives: Identify the key factors that influence supplier selection decisions and organize these factors based on their relationships within the apparel industry in the Colombo District.

Methodology: The population was estimated to include 4,000 sourcing, supply chain, and procurement professionals, and key decision makers in the apparel industry in Colombo, of whom 347 were considered the sample. This research adopted positivism as its research philosophy, as it used measurable data and employed a cross-sectional method to collect data via a structured questionnaire. A deductive approach was applied, relying on previous studies. This thesis examines supplier selection criteria in the apparel industry by identifying factors through prior research, focusing on structuring 37 factors using Principal Component Analysis. The study employed Varimax Rotation to identify the six most influential components (groupings) that represent clusters of the 37 factors relevant for supplier selection.

Results & Discussion: The analysis identifies six key factor components: operational reliability and logistics, technological innovation and strategic alignment, production scalability and demand responsiveness, relationship management, and flexibility. These groupings collectively represent the underlying structure of the 37 supplier selection criteria, establishing them as the most critical dimensions influencing supplier selection decisions in the apparel industry.

Conclusion: The research findings revealed a structured approach to supplier selection based on six key factor components, highlighting that apparel companies can adopt this approach to prioritize and select suppliers who offer these factor components that align with their business goals.

Keywords: Apparel industry, Supplier selection, Supply chain management

The Impact of Visual Merchandising on Consumers' Impulse Buying Behavior : A Study of Fashion Stores in the Gampaha District Sri Lanka

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Introduction: The study examines the impact of visual merchandising on consumers' impulse buying behavior within fashion retail stores in the Gampaha district of Sri Lanka. With the growth of organized retail and rising consumer expectations, visual merchandising has emerged as a critical strategic tool in influencing spontaneous purchasing decisions. The study examines the impact of visual merchandising elements like window display, promotional signage, color and lighting, mannequin display, and floor merchandising on consumers' impulse buying behavior.

Objectives: The research aims to explore the influence of visual merchandising on impulsive buying behavior in fashion stores in Gampaha district, Sri Lanka. It identifies the most significant visual merchandising factor and seeks suggestions to enhance this behavior through visual merchandising in the area.

Methodology: The study was based on the positivism philosophy, employed a deductive approach, and used a quantitative method with structured questionnaires distributed to a sample of 385 respondents selected through convenience sampling. Data was analyzed using descriptive statistics, correlation, and regression analysis through SPSS Software.

Results & Discussion: Window display is the most significant predictor, with a coefficient of 0.273 demonstrating a positive effect on Consumers' Impulse Buying Behavior. Mannequin display and floor merchandising had strong favorable benefits, with coefficients of 0.269 and 0.155. Color and lighting also reveal a positive link however the significance is marginal (p- value = 0.053). Promotional signage has a negative and non – significant impact (p-value = 0.296). These findings confirm that emotional and visual stimuli drive unplanned consumer purchases in fashion retail.

Conclusion: Fashion retailers can boost impulse buying by utilizing visually appealing strategies like color schemes and mannequin displays, adapting these elements to customers' emotions, using innovative digital display methods, and gathering consumer feedback. Further studies can optimize customer engagement and sales growth by tailoring merchandising to demographics or store formats.

Keywords: Fashion stores, Impulse buying behavior, Visual merchandising elements

The Impact of Leadership Style on Employee Motivation; Special Reference to the Koggala Free Trade Zone

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Introduction: The study examines the influence of leadership styles on employee motivation in the Sri Lanka apparel industry, a key export revenue generator. It investigates transformational and transactional leadership styles in the Koggala Free Trade Zone. The research underscores the need for more empirical evidence on how leadership styles influence motivation in Sri Lanka's Free Trade Zones, as most existing research focuses on productivity and managerial outcomes.

Objectives: The research objectives are to analyze the influence of various leadership styles on employee motivation in the Koggala Free Trade Zone of Sri Lanka's Apparel Industry, explore the correlation between leadership styles and motivation, and identify the most influential leadership style for boosting motivation in the Koggala Free Trade Zone.

Methodology: The study utilized a positivism research philosophy with a deductive approach, using a quantitative method and self-administered questionnaires. A sample of 374 operation level respondents was selected through convenience sampling, and data was analyzed using SPSS software for descriptive statistics, correlations, and regression analyses. Transformational leadership was found to be more powerful in motivating employees, accounting for 62% of the variance in motivation compared to transactional leadership.

Results & Discussion: The study reveals that transformational leadership significantly boosts employee motivation in the Koggala Free Trade Zone apparel sector, fostering a sense of purpose, empowerment, and individual contributions, thereby resulting in a more engaged workforce. The study emphasizes the significance of transformational leadership development programs in the apparel industry for boosting employee motivation, reducing turnover, and enhancing organizational performance, particularly in challenging work environments like Sri Lanka's Free Trade Zones.

Conclusion: The study recommends Koggala Free Trade Zone managers focus on transformational leadership, empowering staff, providing constructive criticism, and promoting an inclusive work environment. It also recommends government-funded leadership development programs, workplace safety legislation, and competitive pay packages. Future studies should explore enhancing leadership styles for increased employee motivation.

Keywords: Employee motivation, Leadership, Transformational leadership style

Factors Affecting the Academic Performance of Undergraduate Students in Non-State Universities in Colombo District

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Introduction: The academic performance of undergraduates is a crucial indicator of higher education quality and student success. With the growing prominence of non-state universities in Sri Lanka, it is essential to identify the factors influencing student achievement. Prior studies have largely focused on state universities, leaving a gap in understanding the unique dynamics within non-state institutions.

Objectives: The study aimed to identify key factors affecting undergraduate academic performance, analyze their relationship in non-state universities in Colombo District, examine their impact, and determine the most significant predictor of academic performance among undergraduate students, thereby enhancing the quality of education in the region.

Methodology: A quantitative research design was adopted, with data collected via a structured questionnaire from 385 senior undergraduates in non-state universities in Colombo District. Twelve academic engagement variables were measured. Data were analyzed using SPSS through descriptive statistics, reliability testing, Exploratory Factor Analysis (EFA), Pearson correlation, and multiple regression analysis.

Results & Discussion: Factor analysis extracted two major components: F_01 (Student-Initiated Academic Engagement) and F_02 (Institutional and Socioeconomic Academic Engagement). Correlation results revealed that both factors were positively related to Grade Point Average (GPA), with F_01 showing a stronger relationship ($r = 0.686$, $p = 0.000$) and F_02 showing a relationship ($r = 0.482$, $p = 0.000$). Regression analysis confirmed that F_01 was the most significant predictor of GPA ($\beta = 0.648$, $p = 0.000$), while F_02 was not statistically significant. Findings suggest that self-motivation, study time, and family support exert greater influence on academic success than institutional resources alone.

Conclusion: The study highlights the importance of student-driven engagement in academic outcomes, suggesting that universities and policymakers should focus on fostering self-discipline, motivation, and effective study habits among undergraduates, with practical implications for non-state universities in Colombo District.

Keywords: Academic engagement, Grade Point Average, Non-State Universities, Student motivation

Impact of Telework on Employee Engagement in Top Ten Life Insurance Companies in Sri Lanka

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Introduction: This study investigates the impact of telework on employee engagement in Sri Lanka's top ten life insurance companies. With remote work becoming a long-term strategy, especially in structured industries like insurance, understanding its effect on motivation and performance is.

Objectives: The objective is this study to examine the impact of telework on employee engagement in the top ten life insurance companies in Sri Lanka.

Methodology: A quantitative mono-method was adopted, using a structured questionnaire distributed to 385 non-sales employees under convenient sampling method. Grounded in the job characteristics model and other motivational theories, the data were analyzed using SPSS with correlation and multiple regression. Log transformation was applied to improve model accuracy.

Results & Discussion: Results show autonomy, skill variety, task identity, and task significance positively affect engagement, with feedback showing a weaker influence. Autonomy was the strongest predictor, highlighting that having significant Autonomy boosts engagement in virtual settings. The regression model explained 68.8% of the variance in engagement, validating the research objective. These findings support theoretical models and provide clarity on mixed results in past global studies. They also emphasize the value of redesigning remote roles to sustain motivation and performance in traditional service sectors like life insurance.

Conclusion: Telework can enhance engagement when job roles are structured around key motivational features. Feedback systems need improvement to maximize impact. Future research should consider longitudinal designs and broader industry comparisons. This study supports HR innovation in remote work design and adds value to the growing body of telework research.

Keywords: Employee engagement, Life insurance, Telework

Analyzing the Impact of Logistics Activities on Export Competitiveness of Apparel Sector in Colombo District

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Introduction: Sri Lanka's apparel business accounts for more than 40% of national export profits, but it faces heavy competition from Bangladesh, Vietnam, and Cambodia, as well as post-pandemic and economic issues. Logistics today play a significant role in competitiveness, including timely delivery, quality, sustainability, and customer happiness. Limited research on this topic in Sri Lanka has created a knowledge gap, which this study seeks to fill.

Objectives: The study aims to explore the impact of logistical activities like cost efficiency, delivery speed, sustainability, and customer satisfaction on the export competitiveness of garment exporters in the Colombo District then to identify key factors contributing to competitive advantage and providing recommendations.

Methodology: The study utilized quantitative research design, surveying 1,258 employees from five major garment exporters in Colombo District. A representative sample of 295 was drawn using Krejcie and Morgan's sampling table and a sample size calculator, focusing on executives and managers with logistical operations experience. A standardized questionnaire was used to collect data about demographics, logistical activities, and competitiveness indicators. Cronbach's Alpha values for all constructs exceeded 0.70, indicating reliability. Validity was supported by a high KMO measure (0.947) and significant Bartlett's test (p<0.001). To investigate hypothesized relationships, data was analyzed in SPSS using descriptive statistics, Pearson correlation, and multiple regression.

Results & Discussion: The study found that competitiveness is positively influenced by delivery speed, sustainability, and customer happiness, while cost efficiency has no significant impact. The shift towards value creation through sustainability, dependability, and customer-centric logistics aligns with global literature emphasizing timely delivery and ethical standards.

Conclusion: To shorten lead times, Sri Lankan clothing exporters should embrace green logistics, digital customer service, and supply chain coordination. Although the study is limited to the Colombo District, it gives actionable insights for increasing competitiveness and lays the groundwork for future, broader research into logistics improvements.

Keywords: Apparel industry, Cost efficiency, Customer satisfaction, Delivery speed, Export competitiveness

Analyzing the Relationship between Workplace Dynamics and Employee Satisfaction in Biyagama Manufacturing Sector Sri Lanka

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Introduction: Employee satisfaction plays a crucial role in organizational performance, particularly in labor-intensive sectors like manufacturing. The manufacturing firms face unique challenges that influence employee morale and productivity in Biyagama Zone. However, limited research exists analyzing the combined impact of multiple workplace factors on employee satisfaction within this setting.

Objectives: The study aimed to assess the relationship between wages, working hours, job tension, job security, and work environment with employee satisfaction, identify the most influential factor for employee satisfaction, and propose practical strategies to enhance employee satisfaction in Biyagama manufacturing sector.

Methodology: A quantitative research approach was adopted using 185 responses through a structured Likert-scale questionnaire distributed among employees of 58 manufacturing companies within Biyagama Zone. Using convenience sampling method, employees at different job levels, including managerial staff, general staff, planning staff supervisor, and operational staff, participated in the survey and collected data to capture diverse perspectives on the factors influencing satisfaction. Statistical analysis including correlation and multiple regression was conducted via SPSS to assess relationships and model significance.

Results & Discussion: The regression model indicated a strong explanatory power ($R^2 = 0.844$), suggesting that 84.4% of the variation in employee satisfaction could be explained by the five selected factors. All variables showed a positive and significant relationship with satisfaction. Among them, work environment had the strongest influence ($\beta = 0.316$), followed by job security and wages. All variables showed a positive and significant relationship with satisfaction. Job tension positively impacts motivation, confirming research hypotheses and emphasizing the need for context-specific strategies to enhance worker satisfaction in manufacturing.

Conclusion: The study reveals that workplace dynamics significantly impact employee satisfaction, urging organizations to enhance job stability, fair compensation, and manageable workloads. Future research could explore career growth and supervisor support, thereby enhancing HR practices and policymaking for sustainable industrial development.

Keywords: Biyagama Zone, Employee satisfaction, Manufacturing sector, Workplace dynamics

Factors Affecting the Promotion of Edu-Tourism in Sri Lanka: With Special Reference to the Perceptions of Undergraduate Students at Local Universities

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Introduction: Educational tourism is an emerging niche within the tourism sector that integrates learning with travel experiences. Despite Sri Lanka's potential, it has yet to fully capitalize on this opportunity. Countries such as Malaysia and Thailand have successfully positioned themselves in this field. This study addresses this gap by examining how undergraduate students perceive the factors influencing the promotion of Education tourism in the country.

Objectives: The study seeks to identify the critical factors affecting the promotion of educational tourism in Sri Lanka and evaluates the influence of perceived benefits, institutional quality and reputation, infrastructure and facilities, and cost of education and living on student perceptions.

Methodology: A quantitative research design was adopted, and data was collected through a structured questionnaire distributed among 384 undergraduate students across state and non-state universities. Convenient sampling methods have been used for the study. The data were analyzed using reliability testing, descriptive statistics, correlation, and regression analysis to ensure statistical validity and robustness.

Results & Discussion: The analysis revealed that all examined factors significantly influence the promotion of educational tourism. Correlation analysis confirmed that improvements in institutional quality and reputation, infrastructure, cost of education and living, and perceived benefits are linked to more favorable student perceptions. Enhancing academic standards, campus facilities, affordability, and perceived value of educational experiences can strengthen Sri Lanka's appeal as an education tourism destination. The results also align with global trends, where institutional reputation and quality play a decisive role in attracting international students, indicating that prioritizing these areas could enhance Sri Lanka's competitiveness in the regional Edu-tourism market.

Conclusion: Sri Lanka has significant potential as an educational tourism destination, but growth requires enhancement of academic quality, infrastructure, targeted marketing, and affordability. This study contributes to theoretical understanding of student-centered perceptions in educational tourism promotion.

Keywords: Edu tourism, Higher education, Tourism promotion, Undergraduate perceptions

Optimizing Inventory Levels through a Hybrid EPQ-POQ Model -Empirical Analysis from XYZ Company

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Introduction: This study develops a hybrid Economic Production Quantity–Production Order Quantity (EPQ–POQ) model to optimize inventory management in Sri Lanka's rubber manufacturing sector, where firms face demand volatility, lead time uncertainties, and fluctuating costs. Using four years of secondary data from XYZ Company, the model integrates production and procurement strategies, incorporating lead time, safety stock, and cost components to minimize total inventory costs. Implementation was performed using Excel Solver and Python-Pulp, demonstrating a practical framework for data-driven decision-making under uncertainty.

Objectives: The study aims to find the Optimum Quantity of Inventory in XYZ company and to find the Total Cost of Inventory in XYZ company through a hybrid EPQ-POQ framework that integrates procurement and production planning.

Methodology: A quantitative approach was applied using 4 years of secondary data from XYZ Company. Key variables included monthly demand, production, holding costs, ordering costs, and inventory levels. The hybrid model was implemented in Python using the Pulp optimization method. The model's objective function minimizes total cost while considering lead time variability and a 95% service level using statistical safety stock under production and storage constraints.

Results & Discussion: Results show that the hybrid model effectively combines in-house production and external procurement while addressing demand fluctuations and lead time uncertainties. Applied to four years of actual data (2021–2024), the model identified an optimal quarterly order quantity of 196,010.75 kg in 2024, achieving a total inventory cost reduction of USD 686,631.52 (20.12%). The study demonstrates the robustness and adaptability of a mathematical optimization model, highlighting its potential to improve operational efficiency and cost-effectiveness by reducing stockouts, overstocking, and improving inventory turnover through data-driven decisions.

Conclusion: The hybrid EPQ-POQ model provides a cost-effective solution for manufacturers in uncertain environments, with potential for future research into multi-item extensions, AI forecasting, and industry-wide applications.

Keywords: Cost minimization, Economic Production Quantity, Inventory optimization, Lead time, Production Order Quantity

Analyzing the Impact of Just-In-Time Implementation on Production Performance in Large Scale Apparel Sector in Colombo District

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Introduction: This study addresses the limited understanding of how Just-In-Time (JIT) practices influence production performance in Sri Lanka's apparel sector within the Colombo District. While lean strategies are widely used, the distinct role of JIT remains underexplored. This research fills that gap by examining the specific benefits and challenges of JIT implementation in large-scale apparel firms.

Objectives: The study aims to analyze the impact of JIT implementation on production performance, assess the relationships between JIT practices and performance outcomes, and identify the most influential JIT factor.

Methodology: Following a positivist, deductive approach, primary data were collected via a structured questionnaire with 166 respondents from supply chain, procurement, manufacturing, and operations departments in large-scale apparel firms in Colombo. Ten JIT-related independent variables and one dependent variable were measured using a 5-point Likert scale. The population size was considered unknown, and Cochrane's formula was applied to estimate a target sample of 384. The purposive sampling technique was used. The aim is to select employees who have direct experience with JIT practices in the mentioned departments. SPSS software facilitated Pearson correlation and multiple regression analysis, with significance set at $p < 0.05$.

Results & Discussion: The data followed a normal distribution, and all variables showed acceptable reliability. Correlation analysis confirmed positive and significant relationships between all JIT practices and production performance. Regression results indicated the model's high fitness ($R^2 = 74.5\%$). However, only four JIT practices JIT purchasing, process quality improvement, productive maintenance, and multi-function employees showed significant impacts, while the other six independent variables were rejected in hypothesis testing because they are not significant at $P < 0.05$.

Conclusion: The study confirms JIT's potential to improve production performance but warns of geographical and scope limitations. Future research should expand to broader regions, use longitudinal methods, and examine digital integration.

Keywords: Apparel sector, Colombo district, Just-In-Time, Production performance

The Impact of Social Media Influencer Credibility on Skincare Brand Equity: The Mediating Role of Brand Credibility: Among Generation Z in Western Province

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Introduction: Influencer marketing is an emerging marketing trend in the world. However, brands are skeptical about the credibility of influencer marketing in building brand equity. This study analyses the mediating role of brand credibility on influencer credibility and brand equity, and the demographic Generation Z is considered for this study.

Objectives: The primary objective of this study is to find how the credibility of social media influencers impacts brand equity for skincare brands, and to understand the mediating role of brand credibility in linking influencer credibility to brand equity in skincare brands.

Methodology: The independent variables are Attractiveness, Expertise and Trustworthiness of the study, and the dependent variable is Brand Credibility. The primary data for this study was collected using a survey questionnaire. The convenience sampling technique is used to distribute the questionnaire to 382 respondents. The collected data was analyzed using the SPSS package. Correlation, Multicollinearity, Multiple Regression, and Mediation Analysis techniques were used.

Results & Discussion: The influencer credibility and the brand equity have a strong positive correlation, the trustworthiness of influencers and the brand equity have a strong positive correlation, the expertise of the influencer credibility has a strong positive correlation, the attractiveness of the social media influencer credibility has a moderate positive relationship, there is a moderate positive relationship between the influencer credibility and brand credibility.

Conclusion: Based on the results, it is recommended to select credible social media influencers for the brands.

Keywords: Brand credibility, Brand equity, Generation Z, Influencer credibility, Influencer marketing

The Factors Influencing Customer Purchase Decisions in Maritime Bunkering at the Port of Colombo, Sri Lanka

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Introduction: Maritime bunkering is a highly competitive and strategic sector for Sri Lanka, yet very few studies have examined the factors influencing customer purchase decisions in this area. The Port of Colombo, the busiest port in the country and a key hub along major East–West shipping routes, has not been studied in terms of these factors. This research addresses this gap by investigating the factors influencing customer purchase decisions, providing insights into how infrastructure, market conditions, and operational aspects shape purchasing behavior and affect the port's competitiveness.

Objectives: The objectives of this study are to identify the factors influencing customer purchase decisions in maritime bunkering at the Port of Colombo, examine the relationships between these factors and customer decisions, assess the extent of their impact, and determine the most influential factor affecting such purchasing behavior.

Methodology: This study employed a quantitative research approach. Data was collected through an online structured questionnaire from 141 bunker brokers, who bring vessel bunkering requirements to the Port of Colombo and act as intermediaries between vessel owners or charterers and bunker suppliers. The data were analyzed using SPSS software.

Results & Discussion: The study identified three key groups influencing purchase decisions: operational factors, market and regulatory factors, and infrastructure and accessibility. Correlation analysis showed a positive relationship between these factors and customer purchase decisions. Regression analysis revealed that 58.3% of variation in purchase decisions is explained by these independent variables. Infrastructure and accessibility had the most significant (0.550) impact, while operational factors had the least (0.281).

Conclusion: The Port of Colombo's customer purchase decisions are influenced by infrastructure and accessibility, market and regulatory factors, and operational factors. Smooth port entry, modern facilities, skilled personnel, and efficient digital systems are crucial. The study suggests improving bunkering services and integrating emerging technologies like green bunkering and digital solutions in Sri Lankan ports for future research.

Keywords: Bunkering, Customer purchase decisions, Maritime, Port of Colombo, Supply chain management

Impact of Training & Development on Employee Performance: Special Reference to Apparel Organizations in Gampaha District of Sri Lanka

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Introduction: Employee performance is a key component of organizational success in Sri Lanka's dynamic and competitive apparel sector, especially in the Gampaha district. The performance of executive level employees in top apparel companies in Sri Lanka's Gampaha district is examined in this study in relation to training and development dimensions, such as training needs analysis, training design, training implementation and training evaluation.

Objectives: Investigating the impact of training and development on employee performance in apparel organizations in Gampaha district is the primary objective of this study. The study specifically seeks to determine the relationship between employee performance and training and development dimensions, including training needs analysis, training design, training implementation and training evaluation. Additionally, it aims to identify the most important training and development dimension that improves employee performance in the apparel sector.

Methodology: Targeting executive level employees from MAS Shadowline, Brandix Lanka, Hirdaramani Apparel and Star Garment, a quantitative, cross-sectional design was used. Convenience sampling was used to gather data from 273 executive level employees via a standardized questionnaire due to limited resources and time constraints. SPSS was used for analysis, employing multiple regression and correlation analysis.

Results & Discussion: The results showed that employee performance and all dimensions of training and development had a strong positive correlation ($r > 0.85$, $p < 0.001$). Regression analysis confirmed that Training Needs Analysis had the highest impact ($B = 0.516$), followed by Training Evaluation and Training Design.

Conclusion: According to study's findings, through training and development dimensions significantly improve employee performance. The findings imply HR should optimize training and development programs to improve executive-level performance. Future research could investigate longitudinal impacts and expand to other districts and industries.

Keywords: Apparel industry, Employee performance, Training and development

The Impact of Digital Marketing Strategies on Spiritual Tourism Among Sri Lankan Domestic Tourists: A Quantitative Study

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Introduction: Digital marketing strategies such as social media, influencer marketing, SEO, and video content are widely applied in global tourism. Their role in Sri Lanka's spiritual tourism, particularly among domestic travelers, remains underexplored. This research gap is important as domestic demand for spiritual travel is increasing, yet targeted digital marketing efforts remain underutilized. Addressing this issue, the study investigates how various digital marketing strategies influence the travel decisions of Sri Lankan domestic tourists engaged in spiritual tourism.

Objectives: To find out the impact of social media, video, influencer, mobile, website content, and SEO marketing on travel decisions of Sri Lankan domestic tourists. It also finds out which strategy has the greatest impact.

Methodology: A quantitative research design was adopted, using a self-administered questionnaire distributed (385) among Sri Lankan domestic tourists interested in spiritual travel. Data was analyzed using SPSS software through descriptive statistics, correlation analysis, and regression analysis to test the study hypotheses.

Results & Discussion: The findings revealed that social media marketing, video marketing, mobile marketing, and influencer marketing have a significant positive impact on domestic tourists' travel decisions. in contrast, SEO and website content marketing were found to be statistically insignificant. These outcomes highlight the importance of visually engaging, mobile-friendly, and influencer-driven content in shaping domestic travelers' choices, while traditional website and search engine approaches appear less effective.

Conclusion: The study concludes that digital marketing strongly influences Sri Lankan domestic tourists' interest in spiritual travel. Future campaigns should emphasize emotionally engaging strategies such as social media and video, improve mobile outreach, and expand influencer collaborations to accelerate the growth of domestic spiritual tourism.

Keywords: Digital marketing, Domestic tourists, Spiritual tourism, Sri Lanka

Study on Factors Affecting Women's Career Growth in the Hospitality Industry with Reference to Five-Star Hotels in Colombo Area

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Introduction: Women constitute a substantial proportion of hospitality staff yet remain under-represented in leadership. This study addresses an empirical and practical gap, scarce quantitative evidence on factors constraining women's career progression within Colombo's five-star hotels. Building on national employment patterns and literature gaps, the research examines four organizational and social factors glass ceiling effect, work-family balance, organizational culture and gender stereotyping and their influence on career advancement.

Objectives: To analyze the key factors influencing women's career growth in the hospitality industry and to analyze the impact of the identified factors on career progression in five-star hotels in Colombo.

Methodology: Guided by a positivist philosophy and a deductive quantitative approach, a cross-sectional survey (structured 5-point Likert questionnaire) was administered. Convenience sampling targeted female employees across seven registered five-star hotels; the planned sample was 384 and 157 valid responses were obtained. Data were analyzed in SPSS using reliability testing, descriptive statistics, Pearson correlation, and multiple regression.

Results & Discussion: Pearson correlation indicated strong bivariate associations. Multiple regression showed that organizational culture, work-family balance and glass-ceiling variables significantly predict women's career growth, with organizational culture the strongest predictor. Gender stereotyping, while strongly correlated in bivariate tests, was not significant in the combined model. Reliability, ANOVA and diagnostic checks (model summary and coefficient tables) confirm the robustness of these findings and their implications for HR practice.

Conclusion: The study confirms persistent organizational barriers to women's upward mobility in Colombo's five-star hotels. Recommendations include inclusive culture change, structured mentorship, transparent promotion criteria and family-friendly policies to improve gender equity, career mobility and retention.

Keywords: Career advancement, Gender equality, Gender stereotyping, Women in hospitality, Work life balance

Assessing the Impact of Service Quality on Tourist Satisfaction: Special Reference to Bandaranaike International Airport, Sri Lanka

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Introduction: As the main international gateway, Bandaranaike International Airport (BIA) plays a key role in shaping tourists' first impression of Sri Lanka. Although the airport has undergone recent upgrades, service inconsistencies remain, and limited recent literature has focused on tourists' experiences, particularly in the post-pandemic context. This study aims to address that gap by assessing how current service quality at BIA affects tourist satisfaction.

Objectives: This study aims to analyze the impact of service quality on tourist satisfaction at BIA and identify the most influential factor by examining their relationship.

Methodology: The study's population comprised tourists arriving at BIA, with data collected from 292 respondents. Following a positivism philosophy and deductive approach, a quantitative method using a structured questionnaire was employed, with convenience sampling applied due to time and access constraints at BIA. The SERVQUAL model's five dimensions (reliability, responsiveness, assurance, empathy, and tangibility) were treated as independent variables, and tourist satisfaction as the dependent variable. Data were analyzed in SPSS using reliability analysis, descriptive analysis, Pearson correlation test, and multiple regression analysis.

Results & Discussion: The study found that reliability, responsiveness, and empathy significantly enhance tourist satisfaction, with responsiveness being the most influential factor. Tourists prioritize timely, helpful service over infrastructure or formalities, suggesting airport management and national tourism policymakers should focus on operational efficiency, staff training, and customer-centric service strategies.

Conclusion: BIA should enhance tourist satisfaction by improving responsiveness through faster service, multilingual help desks, and queue management systems. Strengthen reliability through coordinated operations and real-time feedback tools. Enhance empathy through cross-cultural awareness training and inclusive support. Improve assurance through staff development and confidence-building communication. Elevate tangibility by upgrading infrastructure, enhancing multilingual signage, and improving cleanliness.

Keywords: Airport experience, Service quality, Sri Lanka tourism, Tourist satisfaction

Impact of Environmental Sustainability Practices on Corporate Profitability: With Special Reference to the Apparel Industry in the Western Province, Sri Lanka

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Introduction: Environmental sustainability is a vital strategic factor, particularly in resource-intensive industries like clothing. Despite being a hub for apparel production, Sri Lanka's Western Province faces major environmental challenges. This study explores how sustainability practices waste management, emission reduction, energy efficiency, and renewable energy affect garment firms' profitability.

Objectives: This study investigates the impact of environmental sustainability measures on the profitability of Apparel industry in Sri Lanka's Western Province, identifying the most influential practices and evaluating their relationship with financial performance metrics.

Methodology: Structured questionnaire was used to gather 391 valid responses from clothing executives and above management in the Western Province of Sri Lanka for a quantitative study with convenience sampling. Variable associations were tested using regression, correlation, and descriptive analysis using SPSS.

Results & Discussion: The study finds that waste management, carbon emission reduction, and energy efficiency, renewable energy adoption greatly increases profitability. Costs are reduced, stakeholder trust is increased, brand value is increased, and compliance is guaranteed by these methods. Achieving long-term financial success requires treating sustainability as a fundamental business strategy rather than just a legal requirement.

Conclusion: Environmental sustainability ensures long-term financial success in the apparel industry by boosting competitiveness and resilience. Future research should include social and economic factors across wider regions. Policymakers and business leaders must drive sustainability-led growth through capacity building and supportive policies.

Keywords: Apparel industry, Corporate profitability, Energy efficiency, Environmental sustainability, Waste management

An Analysis of the Impact of Front Office Service Quality on Customer Satisfaction in Five-Star Hotels in the Colombo District

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Introduction: In the five-star hotel sector, the front office serves as the initial point of contact and plays a crucial role in shaping customer perceptions. Despite significant investment in infrastructure, the quality of human service remains a key driver of guest satisfaction. While the SERVQUAL framework has been widely applied globally, there is limited research exploring its relevance to front office service quality in Sri Lanka's five-star hotels.

Objectives: The study aims to examine how the SERVQUAL dimensions, tangibility, reliability, responsiveness, assurance, and empathy, affect customer satisfaction. It also identifies the dimension with the strongest impact, offering actionable insights for enhancing luxury hotel service delivery.

Methodology: The study population comprised guests staying at five-star hotels in the Colombo District, with data collected from 247 respondents. A positivist philosophy and deductive approach were adopted using a quantitative research design. A structured SERVQUAL questionnaire and convenience sampling were used. The SERVQUAL dimensions were treated as independent variables and customer satisfaction as the dependent variable. Data were analyzed using SPSS, including reliability analysis, descriptive statistics, Pearson correlation, and regression analysis.

Results & Discussion: Front office service quality significantly impacts customer satisfaction in Colombo's five-star hotels. It fosters trust and emotional connection through responsiveness and empathy. Other aspects moderately enhance guests' perception of professionalism and comfort, highlighting the importance of quality of service.

Conclusion: Enhancing responsiveness and empathy in front office services is essential for improving guest satisfaction, fostering loyalty, encouraging repeat business and strengthening competitiveness. Managers should prioritize service consistency, staff training, and emotional intelligence. Future studies could explore cross hotel and cross regional comparisons to validate these findings.

Keywords: Customer satisfaction, Five star hotels, Front office, Service quality

Employee Commitment in the Relationship Between Blue Ocean Leadership Style and Organizational Performance in the Hotel Industry in Colombo

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Introduction: Organizations are continuously searching for proper leadership styles that enhance innovation, employee involvement, and sustainable value creation. Blue Ocean Leadership (BOL) demonstrates a strategic shift from traditional command-and-control approaches toward unlocking the untapped potential of employees. This leadership style demonstrates empowerment, decreased bureaucracy, and value-driven leadership practices, which align with modern organizational needs. Sri Lanka's hotel industry, particularly in Colombo, is grappling with challenges like employee turnover, poor service quality, and recovery pressures due to economic and social issues. Despite its potential, there are limited studies on the impact of Business Operating Models (BOL) on organizational performance and employee engagement.

Objectives: This study explores the relationship between Blue Ocean Leadership (BOL) and organizational performance, and the moderating effect of employee commitment on this relationship.

Methodology: The study used a quantitative framework and random sampling to investigate the correlation between Blue Ocean Leadership and organizational performance in 200 operational-level employees at selected star hotels in Colombo. The self-structured questionnaire was distributed to ensure diverse staff representation and examined whether employee commitment moderates this relationship. The data was analyzed using SmartPLS 4 for statistical accuracy, involving measurement model assessment, structural model assessment, and moderation analysis. The analysis assessed reliability, convergent validity, discriminant validity, path coefficients, and predictive relevance, and examined the interaction term between Blue Ocean Leadership and employee commitment.

Results & Discussion: The study confirms the positive relationship between Blue Ocean Leadership and organizational performance, with employee commitment as a moderator influencing the relationship between the two variables.

Conclusion: The study suggests that hotel industry management should implement HR policies like flexible working hours, diversity and inclusion, skills training, and support to reduce barriers and enhance employee commitments. This research will benefit industries like the hotel industry, government, and academia by understanding blue ocean leadership and achieving better organizational performance.

Keywords: Blue Ocean Leadership, Employee commitment, Hotel industry, Organizational performance

Using Data Analytics to Address Socio-Economic Factors Influencing Urban Youth Unemployment in Sri Lanka: Special Reference in Colombo District, Sri Lanka

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Introduction: Youth unemployment in Colombo District, Sri Lanka, is a significant socio-economic challenge, with rates substantially exceeding the national average. Rapid urbanization exacerbates educational mismatches, skills gaps, gender disparities, and infrastructural limitations, necessitating understanding these dynamics for effective interventions.

Objectives: This study aims to apply data analytics to identify and quantify the socio-economic determinants of youth unemployment in the Colombo District. It examines the influence of education, vocational training, age, gender, household income, digital access, and transportation on employment outcomes.

Methodology: A study of 472 youth in Colombo used stratified random sampling and cluster sampling to collect data online. The relationship between predictor variables and youth unemployment/employability was analyzed using binary logistic regression and multiple linear regression models.

Results & Discussion: The binary logistic regression revealed significant effects of education ($\beta = 0.743$, $p = 0.04$), vocational training ($\beta = 0.621$, $p = 0.01$), age ($\beta = 0.834$, $p = 0.01$), and gender ($\beta = 0.432$, $p = 0.03$) on youth unemployment odds. Increased education and vocational training were associated with a reduced likelihood of unemployment, whereas female gender was linked to a higher unemployment risk. The multiple regression analysis indicated that household income ($\beta = 0.821$, $p < 0.001$), digital access ($\beta = 0.721$, $p < 0.001$), and gender ($\beta = 0.600$, $p < 0.001$) positively influenced employability scores, while transportation barriers negatively impacted employability ($\beta = 0.410$, $p < 0.001$). These findings underscore the critical importance of aligning skill development initiatives with labor market demands and addressing socio-economic disparities through targeted policies to effectively reduce urban youth unemployment.

Conclusion: The study highlights the importance of data analytics in identifying urban youth unemployment drivers and designing evidence-based interventions in Colombo District. It suggests that enhancing vocational training accessibility, improving digital infrastructure, and addressing gender-specific barriers can significantly reduce youth unemployment.

Keywords: Binary logistic regression, Employability, Socio-economic disparities, Vocational training, Youth unemployment

Factors Affecting Women's Defiance for Participation in the Logistics Industry in Sri Lanka

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Introduction: Despite progress in Sri Lanka's labor market, the logistics industry remains heavily male-dominated, with women representing only 3.4% of the transport and storage workforce. This imbalance restricts diversity and innovation. Understanding the barriers women face both from their own perspectives and from industry practices is essential to create inclusive workplaces.

Objectives: This study aims to: identify the key factors contributing to women's reluctance to participate in Sri Lanka's logistics industry; analyze the individual relationships between these factors and women's participation; and determine the most significant factor influencing women's decisions.

Methodology: A quantitative approach was employed. Data were collected from 385 women in the Colombo district, including those employed in logistics and other sectors, through a structured questionnaire. Reliability was tested using Cronbach's alpha (> 0.8). Factor analysis, correlation, and multiple regression were conducted in SPSS to test three dimensions: Performance Pressure, Boundary Heightening, and Role Encapsulation against women's defiance to participate.

Results & Discussion: Regression analysis confirmed that all three dimensions significantly affect women's defiance, with Boundary Heightening ($\beta = 0.412$, $p < 0.01$) being the strongest predictor, followed by Role Encapsulation ($\beta = 0.298$, $p < 0.01$) and Performance Pressure ($\beta = 0.241$, $p < 0.05$). Women identified disproportionate performance expectations, gender wage gaps, exclusion from leadership, and confinement to "feminine" roles as key barriers. These are reinforced by societal stereotypes and restrictive organizational cultures.

Conclusion: Addressing these barriers requires targeted interventions: mentoring and flexible work policies to reduce performance pressure; leadership pipelines, wage equity enforcement, and cultural reforms to counter boundary heightening; and cross-training, career development, and anti-segregation initiatives to overcome role encapsulation. Aligning interventions with barrier dimensions will empower women, enhance inclusivity, and strengthen Sri Lanka's logistics sector.

Keywords: Gender disparity, Gender stereotypes, Workforce participation

Leveraging Artificial Intelligence to Optimize Inventory Management and Reduce Holding Costs in Sri Lanka's FMCG Supply Chains: Legal Enablers and Regulatory Frameworks for Adoption

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Introduction: Persistent inventory management inefficiencies plague Sri Lanka's Fast-Moving Consumer Goods (FMCG) sector, particularly among distribution partners and intermediary supply chain participants. Profitability is directly impacted by distributors' and retailers' high forecasting and holding costs. Through automated replenishment, real-time visibility across partners, and predictive analytics, Artificial Intelligence (AI) is revolutionizing inventory procedures globally. This paper examines whether the Sri Lankan legal system sufficiently supports such digital transitions and looks at how AI may help distribution partners anticipate and manage inventories more correctly, which lowers forecasting costs for intermediaries.

Objectives: The study explores the potential of AI in improving inventory forecasting and management for distribution partners, reducing supply chain expenses, and assessing Sri Lanka's legal and regulatory readiness for AI-driven inventory systems.

Methodology: A mixed-method design is used in this investigation. Five to seven legal experts and policymakers will be interviewed with a purposive sample of 12 to 15 organizations, such as distributors, logistics companies, and FMCG manufacturers. Reviews of industry reports, ICT policies, and the Data Protection Act will all be considered secondary data. While cost-benefit modeling and case comparisons will offer quantitative insights to validate conclusions, thematic analysis will be employed for qualitative data.

Results & Discussion: The report suggests that AI techniques, such as real-time inventory systems and predictive analytics, can significantly reduce forecasting costs and overstock. However, legal obstacles like unclear data-sharing regulations, lack of liability frameworks, and lack of regulatory sandbox environments hinder their adoption. To facilitate adoption, the report proposes reforms such as sector-specific AI guidelines, clearer data-sharing and liability regulations, and public-private innovation sandboxes.

Conclusion: The study suggests that AI can enhance inventory management and decrease operating costs in Sri Lanka's FMCG supply chains but requires institutional support and legal reforms for effective implementation. Final recommendations will be presented after completion.

Keywords: AI, Distribution partners, Fast-Moving Consumer Goods, Inventory forecasting

Sustainable Tourism Development: Strategies for Nature-Based Tourism in Bogodol

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Introduction: Years following the COVID-19 pandemic have displayed a considerable rise of interest in nature-based tourism. Considering this increase in interest, general topography of Bosnia and Herzegovina, and the increasing tourist interest in the country, sustainable tourism project "Pathways of Bogodol" was started by UNDP.

Objectives: Providing a possible business and study model within the rural area of Bogodol, establishing both ecological and recreational monitoring of popularity and acceptance of nature-based tourism. Following both the popular response to the idea, and the impact on the destination, it offers us an insight into the practicality of nature-based tourism.

Methodology: Considering the mountainous terrain with multiple hiking paths, canyons, and historical heritage, hiking has been chosen as an ideal form of nature-based tourism. Guides and drones used in the project will provide data about both the participant numbers, ecological impact, and overall enjoyment. Composters established near starting points provide quantifiable data regarding the biodegradable waste created during a single tour.

Results & Discussion: The Tour based system provides us with easily monitored data regarding the variables mentioned. Examining the data, we see an obvious rise in interest from both locals and foreign tourists, with a rise of 37% in the first month of the project. Only 17 cases of littering were recorded, and all were cleaned up, while the biodegradable waste was discarded within the composters. Observation (390) has proved both interest in hiking as a form of nature-tourism, and possibility of establishment of sustainable practices.

Conclusion: Nature-based tourism shows promise as an alternative to traditional tourism practices; however, the area remains relatively niche and novel. For future endeavors, focusing on incorporating described methods in tourist packages could be explored. Furthermore, this model can be modified to include biological, ecological, and other studies with specialized tours.

Keywords: Composters, Ecological, Monitoring, Nature based tourism, Sustainable tourism

Faculty of Humanities & Education

Unveiling the Unseen: Metafiction and the Subversion of Theatre in Sarah Kane's *4.48 Psychosis*

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Introduction: Known for her provocative exploration of psychological and emotional facets, Sarah Kane employs metafiction in the play *4.48 Psychosis*, deconstructing traditional theatrical conventions. As a technique that disrupts boundaries between fiction and reality, metafiction is central in Kane's avant-garde approach. Though the play's portrayal of mental illness and autobiographical elements has been largely studied, a gap remains in understanding how metafiction subverts conventional dramaturgy and reimagines audience interaction.

Objectives: The primary objectives of this study were to identify key metafictional elements within the play, explore how they subvert traditional theatrical forms, and examine their effects on audience reception and the depiction of psychological fragmentation.

Methodology: Utilizing a qualitative methodology, a close textual analysis of the play was conducted through deductive coding. The predetermined codes constituted the destabilization of linear temporality, fluid character delineation, and the breaking of the fourth wall. These codes were derived from Patricia Waugh's Theory of Metafiction (1984), the theoretical framework on which the research was grounded.

Results & Discussion: The findings reveal that Kane's metafictional techniques engender a non-linear narrative that mirrors the protagonist's psychological instability and heightens audience engagement by espousing active participation in shaping meaning. By dismantling narrative coherence and character boundaries, the play allows the audience to align their interpretative process with the protagonist's fragmented mental state. While subverting traditional theatrical forms, *4.48 Psychosis* also offers an unparalleled commentary on the lived experience of mental illness through an immersive representation that discourages audience passivity.

Conclusion: Ultimately, this study highlights the transformative potential of metafiction with its ability to expand the boundaries of theatrical expression and deepen audience experience. Transcending mere autobiographical readings of Kane's work, the study also accentuates her laudable theatrical fusion of form, psychology, and audience interaction, advocating for future research that examines how metafiction is utilized by contemporary playwrights within diverse performance contexts.

Keywords: 4.48 Psychosis, Audience engagement, Metafiction, Patricia Waugh, Subverting theatrical conventions

Enhancing Pronunciation through Listening Skills using 'Elsa Speak' among Foundation Certificate Course Students at SLIIT City University, Sri Lanka.

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Introduction: Pronunciation is a key component of speaking, enhancing the meaningfulness of the English Language (EL). Due to poor awareness among students, the importance of listening to improve one's English Pronunciation (EP) has been ignored, even while considerable mobile applications exist. Existing research highlights the role of listening in improving pronunciation through the use of the mobile app ELSA Speak.

Objectives: This research seeks to assist students in ameliorating their pronunciation by using various listening exercises. It also sheds light on a helpful mobile application for students' self-improvement.

Methodology: This study employed a mixed-method approach, utilizing questionnaires and experimental tests as research instruments. Thirty students were randomly selected from the Foundation Certificate level at SLIIT City Uni. An online questionnaire was administered during the pre-test phase to assess students' initial pronunciation, listening skills, and related learning habits. The experimental group then completed five pronunciation tests, evaluated using the ELSA Speak app. Listening treatments were provided through audio clips, each within a 24-hour intervention period before testing. The post-test phase followed the same procedure to evaluate the progress. Finally, a feedback questionnaire was used to collect participants' reflections on the intervention process. Data analysis employed Statistical Package for the Social Sciences (SPSS) and thematic methods.

Results & Discussion: According to the findings, based on the mean of the inclusive posttests (77.47) was higher than the mean of the pretests (71.57). The increase in the mean score of EP was discovered after the listening treatments by the researchers. An increase in student scores was observed following the treatment. Positive feedback indicated that repetitive practice and Homophone listening activities were beneficial for improvement.

Conclusion: Good listening skills contribute to improved pronunciation. Listening to homophones and the Elsa Speak application can be offered as valuable tools for both students and teachers to enhance pronunciation.

Keywords: Elsa speak application, Homophones, Listening exercises, Listening skills, Pronunciation

The Effects of Different English Accents on Listening Comprehension Among Grade 10 ESL Learners

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Introduction: English, as a global lingua franca, is spoken in multiple accents by speakers from diverse backgrounds. ESL learners often struggle with listening comprehension when encountering unfamiliar accents, as most studies emphasize standard varieties such as British or American. This creates a gap in understanding how learners respond to non-native or less frequently encountered accents.

Objectives: This study aimed to assess how different English accents influence listening comprehension among Grade 9 intermediate-level ESL learners in a private English-medium school. It also explored learners' perceptions of accents and the role of exposure in comprehension.

Methodology: A mixed-methods approach with a pre-experimental design was adopted, involving one group, a pre-test, and a post-test. Eight Grade 9 students, identified at A2-B1 proficiency through recent exam results, were selected via convenience sampling. Listening tasks were developed using YouTube podcast materials representing seven accents-American, British, Australian, Indian, Sri Lankan, Singaporean, and South African selected based on Kachru's (1992) concentric circles. The pre-test established baseline comprehension, and the post-test measured performance after exposure. Quantitative data from test scores were analyzed using Microsoft Excel, while qualitative data from open-ended questionnaires were thematically analyzed following Braun and Clarke's (2006) model.

Results & Discussion: Findings revealed higher comprehension for Indian, Sri Lankan, British, Australian, and American accents, while Singaporean and South African accents caused greater difficulty. Thematic analysis identified four themes: exposure improves comprehension, pronunciation and speed create barriers, understanding accents is globally relevant, and learners recognize English as a pluricentric language. Students reported better comprehension of accents encountered frequently through media and instruction.

Conclusion: The study recommends integrating diverse English accents and explicit listening strategies into ESL curricula. Despite limitations such as small sample size and limited accent range, results highlight the importance of accent exposure in developing global listening skills.

Keywords: Accent diversity, English accents, ESL learners, Listening comprehension

Interpersonal Dependency and Role Dynamics: A Comparative Analysis of George and Lennie in of Mice and Men and Ben and Gus in The Dumb Waiter through Robert K. Merton's Role Theory

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Introduction: Interpersonal dependency has been a perennial thematic concern within modern literature, especially in narratives that encapsulate hierarchical power structures and relationships characterized by emotional reliance. While dependency has been scrutinized through Psychological lenses, the Sociological foundations underpinning such relationships remain comparatively underexplored. Accordingly, this study endeavours to address this critical gap through a comparative analysis of George and Lennie in John Steinbeck's Of Mice and Men (1937) and Ben and Gus in Harold Pinter's The Dumb Waiter (1957).

Objectives: A major objective of the study was to investigate how interpersonal dependency in these character relationships is produced, sustained, and destabilised through the interplay of social and personal roles. Another principal objective was to compare and contrast the selected characters in their role dynamics.

Methodology: By adopting a qualitative approach, an in-depth textual analysis of the pivotal scenes in both texts was conducted by utilizing Robert. K. Merton's Role theory (1957) as the theoretical framework. Merton's concepts of role expectations, role sets, and role conflicts were employed to examine how the four characters, George and Lennie, and Ben and Gus, navigate conflicting and overlapping roles within their relational contexts, and how these dynamics structure their dependencies.

Results & Discussion: The analysis demonstrates that George's roles as a labourer and caretaker produce acute role conflict, as societal expectations of masculine autonomy oppose his protective responsibility towards the intellectually-challenged Lennie. Similarly, the relationship between Ben and Gus is marked by unstable role expectations and shifting hierarchies, where contradictory professional obligations and personal anxieties create escalating emotional strain and dependency.

Conclusion: In essence, Merton's theory can be deemed efficacious in interpreting the sociological mechanisms that underlie the literary theme of interpersonal dependency. The study accentuates how fictional role dependencies and conflicts reflect real-world relational structures, incentivizing the incorporation of sociological perspectives in future literary research and interdisciplinary applications in Sociology, education, and cultural studies.

Keywords: Interpersonal dependency, Role dynamics, Merton's Role theory

Design Thinking as an Innovative Pedagogy: Advancing Sustainable Education in Technology-Based Universities in Sri Lanka

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Introduction: With the increasing demand for future-ready graduates, technology-based universities in Sri Lanka must evolve beyond traditional content delivery to foster creativity, sustainability, and human-centered innovation. Design Thinking (DT) has gained recognition as a powerful pedagogy that encourages problem-solving through empathy, collaboration, and iterative learning. This study investigates how integrating DT into higher education can support inclusive, sustainable learning in technical disciplines.

Objectives: This study explores the effectiveness of DT in enhancing student engagement, promoting critical thinking, and fostering sustainability-oriented innovation among technology students.

Methodology: A qualitative case study was conducted with 25 software engineering students enrolled in a DT module at the Informatics Institute of Technology. Students worked in teams with assigned roles to ensure accountability. Weekly reflections were collected, marked, and accompanied by faculty comments to guide learning and encourage critical thinking. Structured surveys combining Likert-scale and open-ended questions were also administered. All data were carefully reviewed to identify patterns and group similar points into broader themes representing the key aspects of students' learning experiences.

Results & Discussion: Students demonstrated heightened engagement and the ability to develop innovative, practical solutions to local issues, such as waste management, transportation safety, and sustainable agriculture. The iterative nature of the module encouraged experimentation, collaboration, and critical thinking. Faculty observed improved teamwork and real-world application of technical knowledge. The inclusion of cultural and community perspectives helped ground student innovations in context-specific needs. Key challenges included limited time within semester schedules and the need for greater faculty training.

Conclusion: DT has strong potential as an innovative pedagogy in Sri Lanka's technology universities. It promotes sustainable, student-centered education and prepares learners for socially responsible innovation. Broader implementation will require curriculum flexibility, institutional and policy support.

Keywords: Design thinking, Innovative pedagogy, Sustainable education, Technology universities

Identifying the Barriers to Implementing the Thirteen-Year Guaranteed Education Program in Schools: A Systematic Literature Review

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Introduction: The Thirteen-Year Guaranteed Education Program (13YGEP), introduced by the Sri Lankan Ministry of Education through Circular No. 37/2017, was designed to address the issue of student dropouts following failure in the General Certificate of Education Ordinary Level (G.C.E. O/L) examination. Its primary goal is to retain students who are unable to continue with senior secondary academic streams by offering alternative pathways especially vocational education. The program aims to provide these students with practical skills and competencies to improve their employability, particularly for those marginalized by the traditional academic system.

Objectives: The objectives of this article are to identify the current state of the 13-year certified education program, analyze the literature contained in the research articles to identify barriers to the implementation of the 13YGEP in schools, and assess knowledge gaps that need to be addressed by future research.

Methodology: A systematic literature review was conducted using academic data (Google Scholar and JSTOR) from 2018 to 2024 for articles that directly focus on the 13YGEP program. The study adopted a qualitative research approach, and the content of the relevant research articles was analysed using qualitative thematic analysis.

Results & Discussion: The findings of this study highlighted several critical weaknesses including inadequate physical resources, shortage of qualified teachers, disparities in the implementation of the 13YGEP by national and provincial schools, low contribution from career guidance programmes, insufficient awareness among principals and teachers, limited enrolment of students, and challenges during institutional training. The lack of standardized formats and formal information systems has limited the consistency of the programme across schools. Limited awareness among teachers and school administrators, coupled with low stakeholder participation, has contributed to operational inefficiencies.

Conclusion: The study highlights the need for stronger monitoring, systematic evaluation frameworks, and integrated information systems to improve program implementation. More research is needed to explore stakeholder perspectives and on-the-ground realities to inform future policy decisions and ensure the long-term success of the 13YGEP.

Keywords: Government schools, NVQ, Vocational stream, 13YGEP

Assessing the Feasibility of Implementing Research Education as a Core Subject in Senior Secondary Curriculum: A study on Advance Level Students

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Introduction: The implementation and potential of introducing research education is a topic that has generated considerable academic attention in many education systems, yet remains underdeveloped in Sri Lanka's school curriculum.

Objectives: This study aimed to explore the feasibility of introducing research education as a core subject in the Sri Lankan senior secondary curriculum by examining students' perceptions, identifying implementation barriers, and comparing perceptions across school types.

Methodology: The study employed a mixed-method design. The sample consisted of 102 A/L students, five Advanced Level teachers and five school administrators. A combination of purposive and convenience sampling techniques was employed. A sample of six schools offering A/L classes was purposively selected, comprising three government, one private, and two international. In the selected schools, A/L students were selected through non-probability convenience sampling. The teachers and school administrators were purposively selected from the same schools and a few from other schools. Quantitative data was analyzed using descriptive statistics to summarize the mean values, t-tests were used to assess the students' perceptions and implementation barriers, while one-way ANOVA was conducted to determine whether differences in perceptions existed across the schools. Qualitative data was analyzed using thematic coding.

Results & Discussion: Findings revealed that senior secondary students possessed positive perceptions of implementing research education as a core subject, though barriers were identified, especially in public schools. Further, quantitative results showed that overall mean perception scores were favorable, and there were no significant differences between school types, while qualitative data highlighted the contextual variations. Despite the availability of the national curriculum in international schools, their resources and exposure to research practices may limit the generalizability of the findings.

Conclusion: This research concludes that implementing research as a core subject in the senior secondary A/L curriculum suggests potential feasibility, highlighting the importance of strategic integration of research education, contingent upon the effective resolution of systemic barriers.

Keywords: Barriers, Feasibility, Implementation, Research education, Senior secondary education

Impact of the ChatGPT Mobile Application on the Development of Second Language Oral Proficiency of Sri Lankan Post A/L Students

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Introduction: Limited oral proficiency in English is a major problem for Sri Lankan ESL learners, and this study investigated the effectiveness of the ChatGPT mobile application in improving second language oral proficiency, drawing on Communicative Language Teaching (CLT) as a theoretical underpinning.

Objectives: To investigate the effectiveness of using the ChatGPT mobile application to improve the second language oral proficiency of Sri Lankan ESL learners and to assess the perceptions of Sri Lankan ESL learners regarding the effectiveness of the ChatGPT mobile application in enhancing their second language oral proficiency.

Methodology: The research uses a mixed-methods approach, combining quantitative pre-test and post-test data with qualitative feedback from a Likert scale questionnaire. 16, 2023 post-A/L students with B1 proficiency were selected through purposive sampling, and their speaking proficiency was evaluated using 2023 IELTS speaking tests, and marks were analyzed using a paired-sample t-test to compare pre and post-test results, and learner perceptions were assessed using a Likert scale questionnaire.

Results & Discussion: After a two-month intervention using the ChatGPT application, the post-test results showed significant improvements in students' oral proficiency, with a mean score increase of 3.25 points. Additionally, learner perceptions of the application were also positive, with 93% of students finding the application useful for improving speaking skills and 75% reporting ease of use. The participants highlighted ChatGPT's effectiveness as a conversational partner and the quality of its feedback, which contributed to increased confidence and motivation in speaking.

Conclusion: Despite the small sample size limiting generalizability, the findings suggested that AI-based applications like ChatGPT can be an effective tool in supplementing traditional language teaching methods, promoting autonomous learning, and enhancing oral proficiency. The study contributes to the growing body of research on AI in language learning and highlights its potential for addressing the challenges faced by ESL learners in Sri Lanka.

Keywords: AI-based speaking practice, ChatGPT mobile application, ESL learners,L2 oral proficiency

An Exploration of the Influence of Magic on Religion and Hope in Portraying the Tragic Flaw in the Novel "The Picture of Dorian Gray" by Oscar Wilde

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Introduction: According to research studies limited attention has been paid to the influence of magic on Religion and Hope in creating harmartia in different literary genres. Thus, this research is an explorative study of Oscar Wilde's novel "The Picture of Dorian Gray" elaborating the above phenomenon through use of magic. Wilde uses the magical transformation of Dorian's picture to portray his moral decline, suggesting that the picture itself embodies the novel's central magical force.

Objectives: Thus, this study attempts to examine how the impact of magic in "The Picture of Dorian Gray" portrays the tragic flaw inherent in religion and hope, related to the themes of morality and the brevity of life. This study explores Wilde's magical elements, examining their effects on religion, hope, tragedy, moral awareness, and life's impermanence.

Methodology: This study uses a qualitative approach engaging in a textual analysis of the novel and utilizes the framework of "Moral Ethical Criticism" theory for further in-depth analysis. This literary review includes ten scholarly sources (2015–2023) that thematically analyze Dorian's downfall and the contextual role of magic.

Results & Discussion: The study reveals that magical influence significantly shapes Dorian's harmartia by distorting his values while fueling his moral decay. The magical portrait serves as a moral mirror, symbolizing lost conscience. Magic ultimately emerges as a force that severs the connection between individual ethics, religious beliefs, and reality. The findings are cited maintaining proper research ethics.

Conclusion: Thus, magic creates a contrast between religion and hope, ultimately guiding Dorian's tragedy. Furthermore, a potential direction for future research could be to critically explore how moral and ethical implications of magic impacts the society.

Keywords: Hope, Magic, Religion, Tragic flaw

Investigating the Effectiveness of using English Subtitled Movies on Vocabulary Development: A Study Based on Ordinary Level Students in English as a Second Language

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Introduction: This study examined the efficacy of the English Subtitled movies on vocabulary acquisition among the Grade 10 English Second Language (ESL) students in Sri Lanka. English movies can be found in most countries across the world and they are a favourite source of entertainment to most students who study English as a second language.

Objectives: This study aimed to determine the impact of English subtitled movies on vocabulary development among Grade 10 in Sri Lanka. Specifically, the study aimed to explore how both teachers and students who have to study English think about using English subtitled movies as tools to develop English vocabulary within an English as a Second Language setting.

Methodology: The study uses a mixed-method approach: along with quantitative data from vocabulary tests and a questionnaire, qualitative data including student and teacher perceptions were collected through open-ended questions. Further, the study explored the perceptions of students and teachers regarding their use of English-subtitled movies in learning and mastering vocabulary. It selected 50 Grade 10 students from Sri Subhuthi National College, Battaramulla, dividing them into an experimental group (exposed to subtitled movies over six weeks, one session per week) and a control group (taught using traditional methods). Additionally, 50 English teachers within the Battaramulla Educational Zone participated. Vocabulary knowledge was assessed using the Vocabulary Knowledge Scale (VKS), along with pre- and post-tests.

Results & Discussion: It was demonstrated that the vocabulary knowledge of the learners improved significantly. The results revealed the optimistic perspectives of the teachers and the students to apply English subtitled movies to build vocabulary knowledge.

Conclusion: Concerning the effect of vocabulary development, the research established that English subtitled movies produced a higher impact in helping learners to develop knowledge on vocabulary as a novel technique in the English as a Second Language classroom.

Keywords: English subtitled movies, English as a Second Language, Language acquisition, Mixed-method approach, Vocabulary development

Challenges Faced by Non-Native English Teachers in Delivering the Cambridge and Edexcel Curricula in International schools in Colombo District

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Introduction: Non-native English-speaking teachers (NNESTs) face distinct challenges when delivering the Pearson Edexcel and Cambridge (CAIE) curricula amid the globalization of English language education. Despite the widespread use of these curricula, limited research has examined the specific pedagogical and linguistic difficulties NNESTs encounter in these contexts.

Objectives: To determine the key challenges that NNESTs encounter teaching Edexcel and Cambridge contexts.

Methodology: Twenty secondary-level NNESTs who teach Edexcel and Cambridge curricula in international schools in Colombo were selected for the study. Both quantitative surveys and semi-structured interviews were conducted independently using validated tools. Quantitative data were descriptively analyzed, and qualitative interview data were examined through embedded analysis.

Results & Discussion: Findings indicate that NNESTs navigate the demanding Edexcel and Cambridge assessment frameworks while simultaneously addressing second language learning challenges. Approximately 70% of participants reported difficulties balancing rigorous curriculum expectations with communicative language teaching, a dual pressure linked to elevated stress levels. Many NNESTs also experience feelings of "inferiority complex" or "impostor syndrome," which undermine their confidence and classroom effectiveness. Qualitative insights reveal difficulties in engaging students and managing classroom behavior, exacerbated by varying student motivation, learning styles, and language proficiency levels. Additionally, NNESTs invest considerable effort in adapting Cambridge and Edexcel teaching materials creatively to meet diverse learner needs, contributing to workload stress.

Conclusion: Provide any shortcomings/improvements/suggestions for further progression of the research and future directions, while elaborating how the research outcomes may benefit the scientific and academic community and society.

Keywords: Cambridge curriculum, Edexcel curriculum, English language teaching, International education, NNESTs

From Laughter to Learning: Science Undergraduates' Perceptions of Humour-Embedded Task-Based Learning in English Language Development.

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Introduction: Despite the significant role of English in Sri Lanka and the government's efforts to improve it, the majority of Sri Lankan undergraduates continue to demonstrate limited competence in English language skills even though a myriad of pedagogical strategies has been suggested to change the situation.

Objectives: Against this backdrop, this study investigates undergraduates' perceptions of the effectiveness of humour-embedded tasks in enhancing their English language skills based on the assumption that strategic use of humour can positively influence learners' cognitive, socio-emotional, and motivational domains.

Methodology: Due to researchers' convenience, the study was conducted in the Science Faculty of a state university in Sri Lanka, involving 70 students who scored average marks on the Faculty's English placement test with a mean score of 59.84. Accordingly, these participants were exposed to eight humour-embedded task-based learning sessions over eight weeks, with each session lasting two hours. These tasks were newly developed by researchers utilising humorous short stories, newspaper articles and advertisements. Upon completion of the intervention, data were collected through focus group interviews, audio recorded and transcribed and the transcriptions were sent to the participants for member checking. An inductive approach to thematic analysis was conducted with NVivo 12 used to manage the coding process systematically.

Results & Discussion: The findings revealed that humour-embedded task-based learning created a spontaneous language learning atmosphere enhancing learner motivation, confidence, language activation and authentic exposure. Nevertheless, further concerns were raised regarding effective classroom management, teacher proficiency in implementing humour-embedded tasks and the need to maintain a balance between English and the use of first language (L1) in task preparation.

Conclusion: These findings emphasize both the potential and the pedagogical considerations of introducing humour-based tasks within second language learning (L2) at tertiary education in Sri Lanka.

Keywords: Cambridge curriculum, Edexcel curriculum, English language teaching, International education, NNESTs

A Comparative Analysis of Upward Social Mobility through Education, Love and Culture in the characters "Piyal" in "Uprooted" by Martin Wickramasinghe and "Jane Eyre " in "Jane Eyre" by Charlotte Bronte.

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Introduction: This study presents a comparative analysis of Piyal in Uprooted by Martin Wickramasinghe and Jane in Jane Eyre by Charlotte Brontë, focusing on how education, love, and culture affect their upward social mobility in Colonial Sri Lanka and Victorian England. This research fulfils the existent research gap where previous studies have explored these texts individually, limited attention has been given to their comparative portrayal of social mobility across different historical and cultural contexts.

Objectives: Therefore, this research aims to critically examine how education, love, and cultural values influence the upward social mobility of both characters, in terms of their life choices and relationships.

Methodology: Thus, this study employs a qualitative approach, combining data from an online questionnaire filled by BA undergraduates at CINEC as well as a textual analysis of the two novels. Further, thematic analysis was utilized to explore how the themes of education, love, and culture are represented through different perspectives.

Results & Discussion: The analysis revealed that education is a key factor in both characters' social elevation. Piyal's English education and ambition lead to social acceptance and economic success, while Jane's moral education and inheritance empower her to return as Rochester's equal. Love serves as both motivation and challenge, emotional and conditional in Jane's case, and strategic for Piyal. Culture acts as both a force of preservation and restriction, reinforcing social norms while creating barriers. These findings support the study's aim by illustrating how these elements shape upward social mobility.

Conclusion: In conclusion, Piyal and Jane achieve notable upward social mobility through the intertwined influences of education, love, and culture. Though limited to two texts which limits the study's generalizability, the study maintains ethical standards through participant anonymity. Future research could expand on exploring how gender roles, economic conditions, and societal pressures further affect social mobility in similar characters.

Keywords: Culture, Education, Love, Upward social mobility

Through the Fog of Delusion: A Buddhist Perspective on Tragedy in Shakespeare's Macbeth

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Introduction: Shakespeare's Macbeth depicts the downfall of a man consumed by ambition and guilt. While critics have examined the play through psychoanalytic and political readings, little work applies non-Western psychology. This study addresses that gap by interpreting Macbeth through moha (delusion/ignorance of reality) in Theravāda Buddhism, showing how Buddhist thought enriches cross-cultural literary analysis.

Objectives: The study explores Macbeth's collapse using mohamūla citta (delusion-rooted consciousness). This focus is chosen because it explains distorted perception and inner blindness central to his downfall. It also highlights unwholesome mental factors (akusala cetasikas) such as vicikicchā (doubt) and uddhacca (restlessness), both classified under mohamūla in the Abhidhamma.

Methodology: A comparative literary analysis is used, placing Macbeth beside Abhidhamma psychology. This approach reveals psychological dimensions often missed in Western criticism. Particular attention is given to vicikicchā (indecisiveness) and uddhacca (mental agitation) because they illustrate Macbeth's hesitation, hallucinations, and paranoia.

Results & Discussion: The analysis shows that Macbeth's distorted cognition stems from mohamūla citta. His hallucination of the dagger, obsessive guilt manifesting as Banquo's ghost, and misinterpretation of the witches' words reveal how delusion drives his actions. The witches and Lady Macbeth act only as triggers, while the real cause is his own defiled mind (kilesa).

Conclusion: The study concludes that Macbeth's tragedy arises from internal delusion rather than fate. Although limited by its focus on mohamūla citta, this study recommends extending the approach to other Shakespearean tragedies such as Othello and Hamlet, while also considering lobhamūla citta (greed) and dosamūla citta (hatred) for a fuller Buddhist reading. This demonstrates how Buddhist psychology offers a unique lens for Shakespearean tragedy.

Keywords: Comparative literature, Delusion, Macbeth, Mohamūla Citta, Theravāda Buddhism

Beyond Blood: An Exploration of the Emotional, Social, and Ethical Dimensions of Non-Biological Motherhood in "A Doll's House" by Henrik Ibsen, "The Caucasian Chalk Circle" by Bertolt Brecht and "A Midsummer Night's Dream" by William Shakespeare.

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Introduction: Motherhood has long been a central theme in drama, often represented through biological ties that define women's roles within the family and society. Yet, non-biological maternal figures also play crucial roles, offering alternative perspectives on caregiving and social responsibility. This study examined how such figures are portrayed in Henrik Ibsen's "A Doll's House", Bertolt Brecht's "The Caucasian Chalk Circle", and William Shakespeare's "A Midsummer Night's Dream".

Objectives: The research aimed to analyze how non-biological mothers are represented, how they negotiated caregiving beyond biological connections, and how these portrayals reflected broader societal values. It also highlighted the intersections between maternal responsibility and emotional, social, and ethical dimensions of caregiving.

Methodology: A qualitative, interpretive approach was adopted, involving close reading and thematic analysis of the plays. The analysis was guided by feminist ethics, care ethics, and ethical criticism to explore how characters such as Anna-Maria, Grusha, and Titania embodied caregiving roles and how their choices were shaped by social and cultural contexts.

Results & Discussion: The findings suggested that these maternal figures redefined motherhood as an ethical and social choice rather than a purely biological duty. They challenged patriarchal expectations and emphasized compassion, moral responsibility, and self-sacrifice as central to caregiving. By portraying caregiving as an act of social responsibility, these plays opened new perspectives on maternal identity that remain relevant to contemporary debates on gender roles and justice.

Conclusion: This study acknowledged its limitation in relying solely on textual analysis, excluding audience reception and performance interpretations that could have enriched understanding of non-biological maternal figures' societal impact. It also navigated ethical challenges in discussing sensitive themes, such as societal views on unmarried mothers like Grusha, requiring careful, respectful language. Overall, the research contributed to literary and gender studies by demonstrating how non-biological maternal figures in drama challenge traditional definitions of motherhood and enrich broader understandings of caregiving in society.

Keywords: Caregiving, Drama, Non-biological motherhood, Feminist ethics, Maternal identity

Impact of Artificial Intelligence on Personalized Learning: A student-centered Study

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Introduction: Artificial intelligence (AI) is transforming higher education by enhancing learning experiences through adaptive, efficient, and accessible tools. AI's most notable contribution is personalized learning, enabling students to progress at their own pace with activities aligned to their learning styles. This study explores the growing integration of AI in educational contexts and its impact on students' learning experiences.

Objectives: This research examines student perspectives on AI's impact on personalized learning in higher education, focusing on benefits, challenges, and AI's evolving role in academic environments. The study captures direct insights from university students as primary users of AI tools to identify practical applications.

Methodology: A mixed-methods approach was employed using a voluntary, anonymous survey via Google Forms conducted over three weeks at Sri Lanka Institute of Information Technology (SLIIT). The survey incorporated multiple-choice questions, Likert scale items, and open-ended questions, capturing quantitative and qualitative data from 60 randomly selected students. Descriptive statistics and thematic analysis were used for data analysis.

Results & Discussion: Results revealed widespread AI adoption: 71% of students used AI tools frequently, 21% occasionally, and 8% rarely. ChatGPT dominated usage at 98.3%, followed by Gemini AI at 50%. Most students (74%) found AI tools helpful, with 38% rating them very effective and 36% somewhat effective. However, 22% remained neutral and 4% found them ineffective. Regarding AI replacing teachers, 50.8% opposed this, emphasizing human interaction's importance. Despite accuracy and trust concerns, 98.3% would recommend AI-powered resources to peers.

Conclusion: The study indicates positive reception of AI tools, particularly ChatGPT, with students acknowledging their effectiveness in personalized learning. However, concerns about AI limitations and human educators' irreplaceability persist. Institutions should improve AI reliability while ensuring it complements rather than replaces human teaching. Further research examining long-term educational outcomes is needed.

Keywords: Artificial intelligence, Higher education, Personalized learning, Student perspectives

The Transgressive Power of Journeys in the Novels "Uprooted" and "Wuthering Heights": A Comparative Study on How Piyal's and Heathcliff's Major Journeys Contribute to the Thematic Progression of the Novels

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Introduction: Piyal's journey to Colombo and Heathcliff's exile from "Wuthering Heights" is a result of their unique character traits. This can be interpreted both literally and symbolically through the analysis of the Novels Uprooted by "Martin Wickramasinghe" and Wuthering Heights by "Emily Brontë". It has created the necessary conditions within both protagonists to develop the climax of the novels. The critical analysis of this underexplored research gap, also provides a precise idea about those authors' contemporary societies.

Objectives: The primary objective of the study is to explore the influence of Piyal's departure to Colombo and Heathcliff's exile from "Wuthering Heights" through the analysis of the Thematic Progression of both texts.

Methodology: This qualitative research adopted textual analysis as the data analysis method. Intertextual analysis involved meticulous reading of both texts. Meanwhile, information on culture, class disparity, gender stereotypes and setting was gathered through contextual analysis. Psychoanalytic theory was used to investigate the effects of the diverse psychological conditions experienced by "Piyal" and "Heathcliff". Moreover, Marxist literary perspective was used to analysis the influence of various social factors on "Piyal" and "Heathcliff".

Results & Discussion: Piyal's journey to Colombo created the necessary socio-cultural conditions by contributing to the main theme which is fall of Feudalism and rise of Capitalism. Meanwhile, Heathcliff's exile from "wuthering Heights" transformed him into an 'evil genius', contributing to the themes of love and hatred.

Conclusion: The study enlightens the reader's mind about the impact caused by diverse socio-cultural factors on one's character development. It is also noteworthy to mention that, the studies conducted by other researchers on similar topics were of paramount importance in reinforcing the literary undertones of both texts.Moreover, the influence of relationship dynamics on the character development of "Piyal and "Heathcliff" can be considered as a future research recommendation.

Keywords: Journey, Transgressive power, Uprooted, Wuthering Heights

The Fluency Paradox: How Metalinguistic Awareness Shapes Self-Perceived Fluency Declines among English Undergraduates

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Introduction: English undergraduates in Sri Lanka begin their degrees with functional fluency in everyday English, but academic exposure increases metalinguistic awareness, which can influence confidence and self-perceived fluency in spontaneous informal communication.

Objectives: This study explores how heightened metalinguistic awareness affects students' self-perceived fluency in spontaneous informal communication after entering an English degree program, focusing on confidence, anxiety, and self-monitoring. These three factors shape learners' fluency perceptions. While prior research has explored metalinguistic awareness or language anxiety individually, the interaction between heightened awareness and the aforementioned factors in shaping self-perceived fluency remains underexplored.

Methodology: A survey of 42 English undergraduates in Sri Lanka, mainly 3rd-year CINEC students, was analyzed using descriptive statistics (percentages). Five CINEC undergraduates, chosen for convenience with sufficient academic exposure, participated in semi-structured interviews analyzed via Braun and Clarke's (2006) six-step thematic approach.

Results & Discussion: 75% of participants reported improved fluency and confidence since entering the degree. However, 43% also experienced linguistic hyperawareness during spontaneous informal communication, linked to heightened metalinguistic awareness and internalized pressure as English undergraduates. Survey responses suggest a misconception that academic and casual English fluency are equivalent. Interviews revealed internalized identity pressure and increased self-monitoring during such communication.

Conclusion: The study reveals a fluency paradox: metalinguistic awareness enhances academic English skills but may undermine students' confidence, leading to self-perceived fluency declines during spontaneous English use. Findings highlight the need for pedagogical approaches that develop metalinguistic knowledge alongside confidence in spontaneous informal communication, such as fluency-focused informal practice and confidence-building workshops.

Keywords: Confidence, Fluency paradox, Informal communication, Metalinguistic awareness, Self-perceived fluency

Perceptions of Vocabulary Dissatisfaction in Oral English Communication among BA English Undergraduates

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Introduction: Many BA English undergraduates can manage conversations in English, yet most report a dissatisfaction with their vocabulary due to a perceived lack of precision or sophistication in their word choice. This condition can evoke negative emotions despite their overall communicative competence.

Objectives: This study explores BA English undergraduates' emotional responses to vocabulary dissatisfaction in oral communication, examines the frequency of this experience, and identifies practical solutions to address the issue.

Methodology: The methodology followed a mixed-method approach with convenience sampling. An online questionnaire yielded 68 responses, which were analyzed using descriptive statistics. Additionally, 10 online interviews and covertly recorded natural conversations were analyzed through thematic analysis. The study was further guided by Krashen's Affective Filter Hypothesis and the concept of Willingness to Communicate (WTC).

Results & Discussion: 70.6% of the participants desired to use more vivid vocabulary while 64.7% regretted missed opportunities to articulate themselves clearly, even when conversations were fairly managed. Common emotional responses included anxiety, embarrassment, and disappointment, while anger and jealousy were less frequent. Dissatisfaction was generally greater in formal than in informal contexts. Participants prioritized improving adjectives and verbs over adverbs and nouns, highlighting a focus on descriptive and action-related expression.

Conclusion: Despite being able to communicate ideas, many English undergraduates experience vocabulary dissatisfaction. Natural conversations and interviews were analyzed with participants' informed consent only, ensuring ethical conduct. As a practical and engaging solution, the introduction to a "Scrabble Word-Gaming Club" within the curriculum was shown interest. Nevertheless, the study is limited by its small, convenience-based sample from a single institution, which may affect generalizability. Future research could investigate participants across academic years to determine whether rising proficiency increases self-consciousness and thus intensifies dissatisfaction.

Keywords: Emotions, English undergraduates, Oral communication, Vocabulary dissatisfaction

Fathers in Silence: A Comparative Analysis of Masculinity and Emotional Repression in Saman Wickramarachchi's "Appachchi Avith" and Arthur Miller's "Death of a Salesman"

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Introduction: This study examines representations of masculinity and emotional repression in Saman Wickramarachchi's Appachchi Avith and Arthur Miller's Death of a Salesman. Limited research has systematically compared how similar masculine ideals manifest across distinct cultural frameworks. Both novels feature emotionally restrained father figures who struggle under societal expectations of male strength and silence. Set in post-war Sri Lanka and mid-20th-century America, these works reveal how patriarchal values discourage emotional expression and contribute to psychological deterioration of male family heads.

Objectives: This research examined how father characters hide emotions and follow masculine ideals, analyzing cultural pressures and narrative techniques shaping their men behavior. The study explored how emotional suppression creates mental problems leading to poor communication, emotional distance, and family dissolution.

Methodology: Using qualitative comparative literary analysis through close reading, this study examined character development, thematic elements, and symbolic expressions of silence and repression. The analysis was framed by R.W. Connell's theory of hegemonic masculinity, with cultural contextualization highlighting how Sri Lankan and American social values influenced character behavior. Thematic coding focused on emotional suppression, masculine performance, and family dysfunction.

Results & Discussion: Both Saman and Willy Loman represent emotionally hidden masculinities shaped by strict cultural roles. Saman's silence demonstrated passive repression rooted in trauma and cultural expectations, while Willy's emotional breakdown reflected active resistance to personal failure. Emotional suppression created internal psychological conflict: Saman's withdrawal led to deep family alienation and inability to connect with children, while Willy's repressed anxieties manifested as delusional behavior and self-destruction.

Conclusion: The study concluded that emotional repression leads to psychological disintegration and familial alienation, with silence functioning as both culturally mandated survival mechanism and symptom of masculine identity collapse. These findings contribute to gender studies, cross-cultural literary criticism, and discussions around men's mental health in literary representation.

Keywords: Comparative literature, Emotional repression, Fatherhood, Gender studies, Masculinity

Bridging the Curriculum Gap: The Status of Comprehensive Sexuality Education in Sri Lankan School Textbooks

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Introduction: Comprehensive Sexuality Education (CSE) is a globally recognized educational framework which provides essential knowledge and skills about sexuality, relationships, and health. Despite their valuable adoption internationally, CSE remains under-implemented in the Sri Lankan education system. Although CSE is recommended by national and global guidelines, the implementation of CSE is limited in Sri Lankan curricula.

Objectives: This study aimed to analyze Grade 6–9 Health and Physical Education and Science textbooks in Sri Lanka to assess the inclusion of the eight key concepts of Comprehensive Sexuality Education (CSE) defined in the UNESCO International Technical Guidance.

Methodology: A content analysis was conducted on Health and Physical Education and Science textbooks used in Grades 6–9 within the Sri Lankan curriculum at the school level using descriptive statistics. Each book was thoroughly reviewed for inclusion of the eight key CSE concepts, and the degree of coverage of the key concepts was compared across textbooks and grades.

Results & Discussion: According to the results, Health and Physical Science textbooks included an average of 3.25 key CSE concepts per grade (ranging from 1 to 5), only showing partial coverage. Furthermore, Science textbooks contained none of the eight key concepts across all grades. These outcomes reveal that there is a significant curriculum gap, with Health and Physical Science books having moderate on CSE, while Science textbooks lack all 8 key concepts of CSE content.

Conclusion: The current study highlights a clear gap in CSE incorporation within Sri Lankan textbooks, especially in the major subject textbooks of science. Hence, it is recommended that all eight key CSE concepts be systematically amalgamated into both Health and Physical Science and Science curricula to validate comprehensive implementation of CSE, which aligns with international standards.

Keywords: Comprehensive Sexuality Education, Grade 6-9, International technical guidance, Sri Lankan curricula

Enhancing Learning Outcomes Through Activity-Based Module Delivery: A Study on the "Philosophical Thoughts on Primary Education" Module in the BEd (Hons) Primary Education Programme

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Introduction: The quality of teacher training is important for the success of primary education. The B.Ed (Hons) Primary Education program was started in Sri Lanka because there isn't much specialized training for primary school teachers. However, the first group did poorly in the "Philosophical Thoughts on Primary Education" module because the lectures were uninteresting. This study looks into whether learning through activities leads to better results.

Objectives: (1) to compare performance between lecture-based and activity-based delivery; (2) to find out what restricts students from being engaged; (3) to use activity-based lesson plans; (4) to investigate how the intervention worked; and (5) to explore how students' views on educational philosophy changed.

Methodology: A qualitative-dominant, comparative case study looked at two groups: Cohort 1 (40 people who learned through lectures online) and Cohort 2 (40 people who learned through activities in person). Grades, reflective journals, observations by teachers, and focus group discussions were all part of the data. Both thematic and descriptive analyses were used. The methodology aligns well with the objectives: grades enabled comparison of performance , while reflective journals and focus group discussions uncovered restrictions to engagement and traced changes in students' philosophical views. Activity-based lesson plans implemented in Cohort 2 were examined , and how the intervention works was investigated through content and thematic analysis.

Results & Discussion: Cohort 2 did much better: In Cohort 1, 25% scored more than 65. Activities like debates and role-plays helped students apply what they learned in real life, even though they didn't like the abstract content at first. The results are in line with constructivist theory, which shows that activity-based learning works in teacher education.

Conclusion: Activity-based delivery makes people much more interested and productive. Suggestions include schools using interactive teaching methods and doing long-term studies on student retention. This study helps to reach SDG 4 by showing how to train teachers in ways that work.

Keywords: Activity-based learning, Constructivism, Educational philosophy, Primary education Teacher training

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A Study on the Differences in Near Misreporting Behavior Across Ranks in the Maritime Industry

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Introduction: Near misses are unplanned events that did not result in injury, damage or loss yet, had the potential of doing harm. These events play a crucial role in terms of safety if properly identified and reported. Though modern-day rules and regulations implement proper reporting procedures there are general barriers such as paperwork and blame culture. Past research explores these general barriers while paying little attention to how rank influences near miss reporting.

Objectives: The purpose of this case study is to examine how near miss reporting differs between lower and higher-ranking crew members and to identify why lower ranks underreport incidents despite being mostly exposed to the situations.

Methodology: Literature review was done on two studies where one of them used 223 seafarers and the other had more than 1200 seafarers to gather data and to draw conclusions. The studies were analyzed to extract data related to near miss reporting behavior across different seafarer ranks. Major results were compared to identify gaps and lightly addressed issues. No external sources were used beyond these selected studies.

Results & Discussion: Findings revealed that lower ranking crew Members are less likely to report near misses compared to officers. This is influenced by fear of repercussions, lack of awareness and personal ideas regarding reporting. Ratings show less reporting than higher ranking officers who are highly engaged due to leadership roles and training.

Conclusion: The analysis highlights a clear reporting gap between ranks. Addressing this requires enhanced training, communication, leadership engagement which includes practices that encourage and normalize reporting across all ranks to enhance maritime safety.

Keywords: Maritime safety, Near-miss reporting, Reporting behavior, Safety culture, Seafarer ranks

Identify and Analyses Evolution of Piracy and Territorial Disputes in Southeast Asia

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Introduction: Southeast Asia's critical waterways (e.g.,Malacca/ Singapore Straits) face intertwined security challenges. The evolution of maritime piracy from the colonial era led to modern systematic thefts, and persistent territorial disputes rooted in colonial borders due to the issues in sharing of resources.

Objectives: This study aims to discuss the change of intensity of piracy attacks, organized crimes, analyse how territorial conflicts exacerbate jurisdictional gaps; and analyse impact on regional security cooperation.

Methods & Analysis: Historical analysis and policy review Regional Cooperation Agreement on Combating Piracy and Armed Robbery Against Ships in Asia (ReCAAP), Association of Southeast Asian Nations (ASEAN) frameworks. International Maritime Bureau (IMB) /ReCAAP piracy statistics (in 2000-2023) and contrasted with Somalia, Gulf of Guinea dynamics. There are places in Asian waters that have unresolved territorial disputes (e.g., Sulu and Celebes Seas), which has created ideal conditions for piracy activities, where pirates thrive and evade arresting due to lack of stringent regulations against such activities, in these waters. The jurisdictional conflicts among adjourning nations have created room for the pirates to engage their activities without any fear. However, there are places where regional cooperation is reached among adjourning countries (e.g., Malacca Strait Patrols by Singapore and Indonesian navies in co-operation) has helped to reduced piracy and armed robberies to a certain extent. Still the situation is not perfect as some countries have restrictions on sharing the intelligence which might affect their sovereignty and security with respect to anti-piracy protocols.

Conclusion: Encourage regional cooperation to combat piracy and enforce maritime security as per ReCAAP and ASEAN Cooperation. Resolving border ambiguities via United Nations Convention on the Laws of the Sea (UNCLOS 1958) mechanism.

Keywords: Cargo thefts, Piracy, Territorial disputes

Enhancing Predictive Maintenance and Operational Efficiency in Ships through Digital Twin Technology

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Introduction: Digital Twin (DT) technology is transforming the shipping industry by creating real-time virtual copies of ship systems based on operating behavior and predicting malfunctions weeks or even months ahead. The following case study describes the application of DT systems in the shipping sector with the aim of optimizing predictive maintenance and improving operational decision-making in vessel operations and port logistics.

Objectives: The research is guided by following two primary objectives, to evaluate how DT technology can improve limitations in traditional ship machinery maintenance and enable predictive, data-driven operations. Furthermore to examine the use of DT in the tracking of vessels, port operations, and making decisions for enhanced efficiency.

Methodology: The study employed review-based research methodology based on five credible sources of scholarly research, industrial case studies, and technology demonstrations. The evaluation was aimed at DT applications in predictive maintenance, IoT-driven monitoring, simulation platforms, and digital port management. The method was to measure the added value of integrating real-time data in both equipment maintenance and total operational decision-making processes.

Results & Discussion: Findings indicate three overall outcomes: (i) reduced downtime and enhanced failure detection in ship machinery by predictive maintenance, (ii) improved maintenance planning and forward-looking measures reducing operational hazards and enhancing safety, and (iii) improved port logistics and ship operation by real-time monitoring and digital simulation. In general, the conclusions show the dual benefits of DT in maintenance optimization and decision-making for operations.

Conclusion: The study concludes that extensive deployment of Digital Twin technology can have the great ability to significantly boost maritime operations with proactive maintenance, reduced risk, and logistics and decision-making optimization. Through connecting predictive maintenance to wiser operational methods, DT offers a path towards greener, smarter, and safer shipping practice.

Keywords: Digital twin technology, Maritime safety

Addressing the Challenges on Implementing Automation on Ship Berthing

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Introduction: Ship berthing is a risky and complex operation which is carried out to navigate large vessels into dock at ports. It is a process carried out under the supervision of experienced bridge team, skilled pilots and with the help of tugboats. This process is often affected by human error, environmental disturbances and can be time consuming. The application of automation through the Doppler shift principle can successfully address the challenges faced and significantly enhance the efficiency.

Objectives: The primary objective of this study is to identify solutions for the problems faced during the application of automation technology for ship berthing using the microwave Doppler shift principle which calculates the frequency change of reflected waves from an obstruction and thereby identifies the relative speed and distance to the target.

Methodology: The application of existing automation technologies, monitoring systems, usage of algorithms to generate safe and efficient berthing paths were reviewed through academic papers, industry reports, and case studies from leading maritime institutions.

Results & Discussion: The main problems identified were reduction of signal accuracy due to rain, fog and mist, interference from other signal reflections and influence of ship's motions to the accuracy of the signal. These problems can be addressed by applying signal processing algorithms, selecting sensor mounting positions to minimize reflections, using multiple signal beams for a better accuracy and deploying multiple sensor systems. Also, proper backup system and trained crew for emergency.

Conclusion: The advancements gained through automation is crucial as it minimizes accidents, improves efficiency, handles environmental and operational uncertainties. Properly addressing the environmental and technological problems faced using algorithms, sensor systems and signal processing enhancements is crucial for the advancement of this technology. Microwave Doppler shift principle provides a reliable foundation in automation for the advancement of the Maritime industry.

Keywords: Automation, Challenges, Maritime industry

A Study about the Impact of Digitalization and New Technology on Sustainability : A Case Study on Colombo Port – Sri Lanka)

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Introduction: Ports worldwide are increasingly implementing digitalization and sustainable initiatives to enhance their quality and competitiveness. As a result, the port of Colombo, faces growing competition internationally from such ports as Singapore, India, and Dubai, with adopted smart port technologies, digitalization, and Sustainable initiatives. This study investigates the digital transformation, finding Information & Communication Technology (ICT) and safety measures most impactful, with sustainability and their impact on competitiveness in Colombo port and its practical applicability.

Objectives: The objective of this research is to investigate the impact of digitalization and Sustainable initiatives to Colombo port and aims to evaluate the existing theoretical framework, identify gaps and limitations and to explore the role of sustainability. This paves path to future researchers to reach higher extents.

Methodology: Quantitative and qualitative data were used to examine the effectiveness of digitalization, sustainability initiatives and applicability of automation. Data through United Nations trade and development databases, from 192 professionals from shipping lines, port authorities, customs, terminal operators and seniors of the maritime industry were obtained. A five-point Likert scale was used, and tested 16 specific hypotheses on automation, connectivity, ICT, Internet of things, sustainability initiatives, and port competitiveness.

Results & Discussion: This study found that ICT and digitalization upgraded the performance and competitiveness of the port while automation of certain areas showed a weaker impact. Excluding Artificial Intelligence and blockchain technologies, overlooking benchmarking against regional rivals are gaps of the study. The port's manual processes contrast sharply with global automated terminals. Therefore, modernization of ports is urgent for modern maritime needs.

Conclusion: Digitalization uplifts Colombo Port's competitiveness. To remain globally relevant, it must adopt advanced technologies while integrating cost-effective sustainability measures. These steps will ensure operational efficiency, timeliness, and establish Colombo Port as a leading hub in South Asia.

Keywords: Automation, Colombo port, Digitalization, Sustainability

Plastic Pollution on Coastal Waters Near Colombo : Challenges and Mitigation Strategies

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Introduction: Colombo, central to Sri Lanka's economy for its rich maritime resources, is increasingly affected by plastic pollution due to poor waste disposal, urbanization, and rising port-based activities.

Objectives: To identify the major causes for plastic pollution on coastal waters near Colombo and to introduce new approaches to mitigate the impact.

Methodology: In order to address the extent of marine plastic pollution, a structured approach was adopted, combining beach surveys, waste categorization reports and interviews from local residents. Secondary data were sourced from Marine Environment Protection Authority (MEPA) reports, peer-reviewed articles, and newspaper records which provided insights for strategizing the mitigation efforts while existing policies were used in reviewing their effectiveness.

Results & Discussion: Significant levels of plastic debris were recorded along coastal waters near Colombo, especially in areas with higher urbanization and improper waste management systems. Among these recorded debris, microplastics stood out as they accounted for nearly 60% of the total plastic particles gathered. Surveys and interviews highlighted the lack of public awareness and weak enforcement of existing laws as major challenges in this crisis. Findings showed that key factors for this disaster are improper disposal of single-use plastics and runoff situations. Community based efforts which include beach clean-ups and public awareness campaigns have not had much success due to the issues of extending their scales. Effective mitigation strategies identified include enhancing municipal waste separation, adopting filtration systems in drainage outlets, and promoting eco-friendly alternatives.

Conclusion: Plastic pollution along Colombo coast acts as an immense threat to ecosystems and public health. Mitigation efforts involve enforcing new policies and integration of filtration systems which acts as interventions for the high concentration of microplastics. Developing similar sustainable habits is the fundamental way to safeguard the environment for the future.

Keywords: Government policies, Mitigation strategies, Plastic debris, Waste management

An Insight into Wind Assisted Propulsion Systems

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Introduction: Wind sail is not new to shipping and is coming back again with new improvements. Wind Assisted Propulsion Systems (WAPS) can be identified as a promising potential for reducing carbon emissions while saving fuels and reducing costs. Hence shipping companies are adopting WAPS because of ability to provide auxiliary power by retrofitting into existing vessels until purposely built vessels are deployed.

Objectives: To identify major feasible wind assisted propulsion systems currently adopting by the industry there by to develop awareness about identified systems in terms of energy efficiency, cost recovery and impact on navigation of vessels.

Methodology: This research uses review-based methodology by gathering data from 25 peer-reviewed articles and identified the major WAPS systems launched. A qualitative comparison was done by evaluating performance index, Fuel saving capability, estimated cost recovery and physical dimensions and impact on ship operations and navigation through data obtained by published articles.

Results & Discussion: The research has identified three major systems namely Rotor sails, Suctions sails and Rigid sails as most feasible. The identified WAPS has own strengths and limitations. They are capable of saving 10% – 30% Fuel savings hence can assume that they will be widely adopted by vessels in future. A thorough comparison of each system is not ideal due to different conditions and design variables. More In depth research is needed to compare each system yet in practical scenario the result might change. Hence this research article develops a holistic view on WAPS.

Conclusion: Ship companies are realizing the wind's untapped potential for reducing carbon emissions and cost. It will drive mass adoption of WAPS on vessels yet the gap of research and development remain to achieve zero emissions by 2050.

Keywords: Fuel efficiency, Sail systems, Suction sail, Wind-assisted propulsion

Identify and Analyse the Impact of Port Services and Supplying Industry on Economic Growth in Sri Lanka

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Introduction: Sri Lanka's calculated location makes it a major participant along the Indian Ocean Maritime Silk Road in worldwide maritime commerce. Colombo and Hambantota ports are central to this role for the reason that they handle much of the country's shipping activities so they increase revenue. We must come to a comprehension of how these ports do contribute to the economic performance. Such understanding is important for us if we hope to strengthen Sri Lanka's Gross Domestic Product (GDP) growth.

Objectives: This review seeks to identify legal gaps so as to improve port infrastructure use and propose sustainable and investment-friendly strategies so that it can increase the impact of port and logistics services on Sri Lanka's GDP while addressing economic, social, and environmental aspects.

Methodology: This study uses data from maritime task force reports with legal sources that include the Central Bank's Safe Cargo Transport Framework. For interpreting findings and drawing conclusions, both international and local data were analysed using indicators from the Sustainable Development Goals.

Results & Discussion: This study reveals that ports and related services contribute more than 50% to Sri Lanka's GDP. Although the Colombo Port has shown a significant contribution to GDP since 2002, That contribution is hampered by outdated operating methods, outdated infrastructure, resource constraints, loopholes in existing laws and regulations, lack of internal institutional relationships, and poor service delivery, which all hinder GDP growth.

Conclusion: Low efficiency and resource constraints limit the full potential of port services, though they contribute greatly to Sri Lanka's GDP. Ship renovation facilities can be developed at Colombo along with Hambantota. To offer up services such as food and water and fuel can increase the national income. Laws should be updated, resources should be added, and investment policies planned ahead should be adopted.

Keywords: Economic growth, Gross domestic product, Port services

Sustainable Practices Used in Cargo Ship Engines to Mitigate Greenhouse Emissions

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Introduction: As 80% of cargo is transported via ships international trade depends on the shipping industry. As global trade is expanding, increased shipping activities cause significant environmental pollution through greenhouse gas emissions from ship engines. Therefore, minimizing the environmental impact of the maritime industry is now crucial and therefore in order to do that, various sustainable practices are utilized to reduce these emissions. This study focuses on exploring the sustainable practices used in cargo ships engines to mitigate greenhouse emissions.

Objectives: To explore current sustainable practices used in cargo ship engines to mitigate greenhouse emissions and to suggest alternative sustainable practices.

Methodology: This study was created by referring to research papers and it adopts a qualitative research design focused on comprehensively exploring sustainable practices in cargo ship engines for greenhouse gas emission mitigation.

Results & Discussion: The study shows that 45% of companies adopted energy-efficient engines, and 30% of companies used low-sulphur fuels hence it can be seen that positive correlation of regulatory pressure with adoption of green technologies. Larger companies are adopting sustainable practices due to better financial and technical resources availability, but cost and technical barriers are the significant challenges for small scale firms.

Conclusion: To promote environmental sustainability, stronger environmental regulations and financial incentives are essential while especially small bodies need support to overcome financial constraints in promoting these emission reduction practices. These findings can guide policymakers and industry leaders to advance sustainability in maritime transport. Failure to implement these measures will ensure environmental targets are not met.

Keywords: Emission reduction, Green technology adoption, Regulatory pressure, Sustainable shipping

Breaching of Work and Rest Hour Requirements and Safety Management System Onboard Ships

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Introduction: Safety Management System (SMS) requirements and work and rest hour requirements were introduced with the aim of eliminating human errors and reducing fatigue related accidents onboard ships. But according to many scholarly articles, it is evident that work and rest hour records manipulated to show the compliance. Further, still accidents and blunders due to human error remain prevalent.

Objectives: Objective of this research is to identify the reasons for breaching of work and rest hour requirements and reasons for breaching safe working procedures provided in the ship's SMS.

Methodology: In achieving the objectives of this research, a structured questionnaire was circulated among 211 seafarers who are in management and operational level sailing as navigating officers and engineering watchkeeping officers excluding ship masters and chief engineers. The questionnaire is based on the last vessel's experience and the nationality of the seafarers were not considered.

Results & Discussion: 59.2% (125) of the seafarers have manipulated the rest hour records and 20.9% (44) of the seafarers have contravened SMS requirements on their last ship. There were no significant relationships between breaching of rest hour requirements and SMS against type of ship, ship's age, experience etc. But forging work & rest hour records while manoeuvring and during port stay was considerably high.

Conclusion: Breaching of SMS requirements is considerably less than breaching of rest hour requirements, nonetheless both should be avoided. International Maritime Organization (IMO) and the flag states shall consider reviewing the manning level requirements in order to enhance the safety onboard.

Keywords: Fatigue, Safety Management System, Work and rest hours

Prevention of Pollution in Coastal Areas

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Introduction: Coastal areas are very important to our environment. They are among the most biologically diverse and economically valuable regions on earth. However, they are facing lot of threats due to the pollution from both land based and marine sources. Degradation of these ecosystems can lead to a huge loss of bio diversity, disruption of local economies, effects on human health etc. So, prevention of pollution in coastal areas has become a challenge.

Objectives: Aim of the study is to explore strategies to prevent pollution in coastal areas, with a focus on the impacts of plastic waste, Industrial discharges, agricultural runoff and to find best practices for minimizing pollution, improving regulatory measures. Also, promoting sustainable coastal management is another objective.

Methods & Analysis: A comprehensive review of recent literature was conducted, along with an analysis of case studies from some coastal regions worldwide. This study evaluates the effectiveness of current pollution prevention programs. Quantitative and qualitative data were gathered from various websites, articles.

Conclusion: Collaborative efforts between industries and local communities can reduce pollution levels and long-term sustainability. Preventing pollution in coastal areas requires improved waste management infrastructure, increased public awareness. Advanced technologies such as real time pollution tracking systems and echo friendly alternatives to harmful substances can also play a major role in protecting the coastal environment.

Keywords: Coastal pollution, Ecosystems, Environmental protection, Sustainable management

Grounded Giants: How Vessels are Damaging Coral Reefs Across Indonesia

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Introduction: Due to heavy maritime traffic, ship groundings are endangering Indonesia's coral reefs. Because Indonesia is an archipelagic nation, its reefs are essential to both coastal protection and marine biodiversity. However, these ecosystems suffer major physical and biological harm because of ship accidents, particularly groundings.

Objectives: Using quantitative measures of live coral loss, increased rubble, and disruption of reef zonation, this study seeks to systematically identify which particular coral reef formations (such as patch, fringing, and barrier reefs) are most susceptible to ship grounding incidents. It also considers the wider ecological impact and recovery potential of the affected areas while assessing the extent of physical damage to both coral species diversity and reef structural integrity caused by vessels of varying sizes.

Methodology: Research was carried out in Indonesian waters between 2017 and 2019 using the LIT judges coral cover, UPT provides photographic evidence, and Fishbone identifies damage sources to collect and analyse reef damage and coral cover.

Results & Discussion: Human error was the primary cause of 78% of groundings, which mostly happened on patch reefs (67%). In areas that were directly impacted, live coral cover decreased by almost 100%, while rubble rose from 11.19% to 61%. The four zones (trajectory, mound, propeller, and dispersal) were severely damaged by larger ships. Per site, between 97 and 109 coral species were affected.

Conclusion: Ship groundings in Indonesian waters, particularly those involving large vessels, result in significant and often total coral mortality within the affected reef zones, causing long-term damage that hinders natural reef recovery. The findings indicate that immediate implementation of more actionable specific navigation protocols and proactive preventive measures is necessary to safeguard the nation's significant coral ecosystems and use reef restoration strategies.

Keywords: Coral reefs, Human error, Live coral cover, Reef damage, Ship groundings

Assessing the Safety Impact of Electronic Chart Display and Information System Usage in Commercial Vessels

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Introduction: Electronic Chart Display and Information System (ECDIS) for ships has been introduced since 2011 with the intention of accuracy and safety of maritime navigation, mandated under Safety of Life at Sea (SOLAS) and guided by Standard of Training and Certification and Watchkeeping (STCW) for seafarers training standards, it is now essential for bridge operations. However, investigations and research show that misuse, overreliance, and human errors can impair its effectiveness.

Objectives: To identify and analyze common operational, technical and human-factor challenges associated with ECDIS use onboard ships, using real-world case studies. This review also aims to provide practical recommendations to enhance safety and effective use of the system.

Methodology: Marine Accident Investigation Branch (MAIB) reports of accidents involving motor vessels Muros, CMA CGM Vasco de Gama, Commodore Clipper, and supporting academic literature were examined to identify recurring human errors and technical challenges in ECDIS use.

Results & Discussion: Findings reveal that overreliance on ECDIS often leads to reduced situational awareness and poor use of navigational methods. Route planning errors and failure to verify chart data at correct scales have led to groundings. In many cases, ECDIS alarms were ignored due to alarm fatigue. Despite mandatory training, bridge officers were often unfamiliar with system functions such as route checks and safety settings. These patterns align with human error models like the Swiss Cheese Model, where system and human failures are combined. Additional issues include integration errors with sensors, poor bridge resource management, and inconsistent regulatory oversight. Future improvements may include AI-supported navigation, better alarm filtering, and standardized audits.

Conclusion: ECDIS offers significant advantages but requires correct use, constant vigilance, and adequate training. This study highlights the need for improved user education, ergonomic system design, and stronger regulatory enforcement to fully realize the system's safety potential.

Keywords: Electronic Chart Display and Information System, Marine Accident Investigation Branch, Navigation, Standard of Training and Certification and Watchkeeping

Analyzing the Impact of Youth Perception on Seafaring Professional Retention in Sri Lanka

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Introduction: The global maritime sector offers substantial economic rewards, even for non-officer roles that require minimal formal qualifications. Despite this, there is a notable lack of interest among young people, particularly those with low educational attainment in pursuing careers as seafarers.

Objectives: To examine barriers faced by less-qualified youth entering seafaring and thereby recommend awareness-based interventions for youth and policy-level strategies for government stakeholders to enhance participation in maritime careers.

Methodology: This study used a qualitative literature review approach. To identify key themes of youth participation, academic journals, policy papers and maritime education studies from Sri Lanka, Norway, Turkey and Kenya published between 2019-2023 were analysed. Sources, including peer-reviewed articles and dissertations, were accessed through academic databases and repositories. Content analysis was applied to examine factors affecting career choices, such as awareness, social perceptions and education pathways.

Results & Discussion: Findings indicate a lack of structured career guidance in schools, low societal prestige for non-officer seafaring roles and inadequate government promotional campaigns. Cultural stigma and misperceptions about the difficulty and dignity of seafaring work also contribute. Although the sector offers higher wages than similar land-based jobs, limited role models, training access and inclusive messaging leave many youths unaware or disinterested. Additionally, policy gaps and inconsistent government support for outreach to less-qualified groups.

Conclusion: The maritime sector in Sri Lanka holds untapped potential for reducing youth unemployment and boosting national economic growth. Addressing educational gaps, societal attitudes and delays in policy implementation is essential. Targeted awareness programs and stronger government-private partnerships can create viable pathways for young individuals, especially those with limited qualifications, to enter the seafaring workforce.

Keywords: Career awareness, Seafaring, Vocational education, Youth employment

The Role of Artificial Intelligence in Enhancing or Replacing Licensed Deck Officers

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Introduction: The growing trend of automation in the marine sector and the possibility of lowering or doing away with shipboard crews especially licensed deck officers are the subjects of this study. The industry hopes to reduce operating costs and upgrade marine safety as technical advancements open the door for autonomous ships. The authors draw attention to a crucial point, though, moving human error from on-site workers to remote operators does not remove risk.

Objectives: The main objective of this case study is to emphasize the potential risks and benefits of reducing crews from vessels due to increasing automation, particularly from the licensed deck officers and how these technological changes will impact operational safety, workload, situational awareness and fatigue.

Methods & Analysis: This case study follows a qualitative approach, using a combination of literature reviews based on maritime autonomous shipping and analysing questionnaires given to the subject experts including ship's senior officers, junior officers and other experts in the maritime sector. These questionnaires used a to measure perceptions of employment, training, safety, and the feasibility of autonomous shipping.

Conclusion: Despite the unavoidable of maritime autonomous shipping, the study found that there are a number of barriers and unknowns surrounding its application, particularly in terms of safety, regulations and crew adaptation. According to a number of participants, cutting crews without corresponding task reductions could lead to increased complacency, overreliance on technology and loss of situational awareness, leaving present seafarers and maritime organizations insufficiently prepared for these changes. But according to the study, seafarers can adapt, and new shore-based roles are emerging that require a change in skill sets. Effectively managing the transition will require proactive efforts in regulation, training and stakeholder collaboration.

Keywords: Autonomous ship, Deck officers, Human error

Safety Advancements in Autonomous Maritime Transport Systems with Real-Time Artificial Intelligence Agent Emergency Prediction

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Introduction: Autonomous maritime transport is evolving rapidly, with real-time AI agents playing a critical role in enhancing vessel safety during emergencies. These AI systems aim to reduce human risk by accurately predicting and mitigating emergency situations.

Objectives: This study aims to assess the current state of autonomous ships and evaluate the efficiency of AI-based safety measures for emergency prediction and risk reduction in real-time maritime operations.

Methodology: A comprehensive qualitative literature review was conducted by systematically searching targeted databases. The review involved the selection of pertinent studies, qualitative data appraisal, and comparative analysis to explore AI agents' functionalities and safety performance in autonomous shipping.

Results & Discussion: The findings highlight that AI agents can reduce collision risk by 40% compared to manual navigation systems. Key safety features identified include emergency coordination, collision avoidance, anomaly detection, and fail-safe redundancy mechanisms. Despite challenges such as high data volume, sensor noise, and cybersecurity threats, AI systems improve safety, legal compliance, and operational efficiency in autonomous maritime transport. The discussion emphasizes the transformative potential of AI while recognizing technical and operational limitations.

Conclusion: Future research should focus on developing robust edge-AI architectures for offline emergency processing, explainable AI for transparent crisis decision-making, and standardized AI-human handover protocols. These advancements will build trust in autonomous shipping technologies, reduce unpredictable risks, and promote sustainable global maritime trade.

Keywords: Autonomous maritime transportation, Emergency prediction, Real-time AI agent

Analyzing the Impact of Technological Efficiency and Regulations on Risk Management of Liquid Fossil Fuel Tankers

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Introduction: 50-60% of oil is transported in the world using Crude oil tankers, but they pose severe safety and environmental risks. This study highlights the safety and importance of oil tanker operations under the main categories of Potential Loss of Life (PLL), and Potential Loss of Property (PLP) by analyzing accident data, risk acceptance criteria, and the effectiveness of regulations. Current risk levels, identifying critical accident patterns, and proposing mitigation strategies for safety concerns are also covered by this.

Objectives: To explore and identify the existing safety regulations with special emphasis on fire, overflow, toxic gases and pollution.

Methods & Analysis: This study has undergone a systematic analysis of data & a literature review by gathering research articles from trusted academic work and websites. Relevant studies are chosen based on credibility, relevance, and recentness. The most authoritative and well-supported articles were selected, analyzed, and refined to derive meaningful conclusions. This methodology ensured a comprehensive and reliable review of existing research.

Conclusion: Development in navigational technologies for handling various types of crude carriers and regulations have improved safety through Vessel Traffic Services (VTS), and stricter maintenance protocols. Limitations of this study are less amount of quantitative data, generalization of Risk Criteria and higher focus on Large Tankers. This study gives a good framework on how regulations should be developed to approach oil transport in coastal areas more efficiently for future study.

Keywords: Crude oil tankers, Formal safety assessment, Maritime safety, Oil spills, Risk management

From Misheard Commands to Disasters: Exploring the Role of Human Miscommunication in Maritime Navigation Crashes

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Introduction: Human errors are leading causes in maritime accidents, affecting shipping operations and safety. Majority of freight transported through ships and due to operational inefficiencies millions of dollars' worth of cargo are lost and even ending-up leaving wrecks. This case study explores how miscommunication between crew-members which is a prominent factor of human error has led to many numerous accidents.

Objectives: The primary objectives of the research are to analyse real-life cases where poor communication led to collisions, to identify the causes of miscommunication in maritime navigation and to assess their impacts on navigation and safety.

Methodology: A qualitative review of existing case studies was conducted first, using five steps to filter out the chosen case studies to understand how miscommunication impacts the performance of navigation. Secondly, a descriptive survey dividing into three sections was executed which involved collecting data on perceptions and experience related, results were tired down to pie charts.

Results & Discussion: The study's findings reinforce that communication plays a crucial role in shipboard work and life, influencing teamwork, morale and even safety as 48.5% voted that miscommunication contributes to maritime accidents and saying that it is dangerous than technological failures. 81.8% says language barrier, 66.7% on poor transmission of commands, 21.2% on technical failures in communication systems and 45.5% voted on lack of standardized protocols. The results highlight the urge for regular briefings (66.7%), encouraging open dialogue (60.6%) and better training while improving maritime English proficiency, advancing communication technology and enforcement of strict protocols to reduce risks.

Conclusion: In summary, this highlights that risk of miscommunication is high due to multi-nationalities onboard vessels hence the chance of language barrier is imminent and thereby executing appropriate countermeasures is recommended.

Keywords: Crew, Miscommunication, Navigation accidents, Shipping industry

Enhancing Hambantota Port as a Shipbuilding Hub

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Introduction: Hambantota International Port is the newest and second largest port in Sri Lanka. However, it has experienced low traffic with limited vessel calls at the port, resulting in limited logistics operations. This research outlines the necessary steps to utilise the port facilities and transform it into a shipbuilding hub and industrial export centre.

Objectives: To identify the strategic, economic, and geopolitical importance of establishing an industrial hub at Hambantota Port and to explore its potential benefits for the Sri Lankan maritime industry and the national economy.

Methodology: This abstract is based on qualitative data on maritime trade routes, Sri Lankan economic and industrial strategies, global shipbuilding trends, and case studies of successful shipbuilding hubs in comparable regions. During this research semi-structured interviews, thematic graphical and statistical analysis, purposive and convenient sampling and self-administered questionnaires were used to get more accurate data for this research.

Results & Discussion: The key findings of the study address the evaluation of the feasibility and viability of proposed developments, proposed solutions to address the growing job shortage in Sri Lanka, strategies to capitalise on international sea routes, environmental and social considerations related to port development and operations.

Conclusion: The shipping industry is rapidly expanding. Despite its strategic location between east and west, Sri Lanka's contribution to global trade remains limited. This research highlights that, with proper planning and support, the project could generate substantial revenue for the country.

Keywords: Challenges, Hambantota port, Opportunities, Sri Lankan economy

Analyse the Impact of Smart Bridge Systems on Minimizing Human Errors

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Introduction: This work critically evaluates a comprehensive qualitative study on Smart Bridge Systems. In the maritime industry, safety is the most important aspect that must be taken into consideration. Accidents and incidents often occur due to both human error and technical failures. Smart bridge technology has been introduced to overcome errors related to complex operational, navigational, and miscommunication challenges.

Objectives: This study aims to identify which elements of Smart bridge technology most effectively address human operational limitations such as situational awareness, navigational mistakes, fatigue, and miscommunication. These errors are largely caused by human errors and manual operations.

Methodology: This research is based on reviews of maritime accidents, case studies, previous research findings on Smart bridge technology and analysis of case studies involving advanced smart bridge systems currently using.

Results & Discussion: The findings of this Study suggest that: Smart Bridge System can significantly minimize the manual workload of officers and they are more efficient than conventional bridge systems. Furthermore they allow real-time sensor integration and offer predictive analytics based on past modern which can enhance decision-making and safety.

Conclusion: Smart bridge systems play a crucial role in reducing the heavy workload experienced by seafarers and in making ship operations safer, easier and more efficient. Furthermore, this technology aligns with modern maritime innovations and is likely to play a key role in shaping the future of the industry. This Study provides a solid foundation for future research and policy development aimed at mitigating human errors at sea.

Keywords: Artificial intelligence, Automation, Human errors, Maritime safety, Smart bridge systems

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Comparative Analysis of Boiler Performance and Emissions in Marine Boilers

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Introduction: This study investigates the performance and emission characteristics of naval boilers operating with different fuel types. The research is driven by the need to support marine engineering efforts aimed at minimizing environmental impact and ensuring compliance with the International Maritime Organization's MARPOL Annex VI emission regulations. It evaluates how various fuels influence the efficiency and emissions output of two commonly used marine boiler models.

Objectives: The primary objective of this research is to evaluate how fuel selection influences the emission characteristics and efficiency of marine boilers.

Methodology: The study tested two maritime boiler systems, Kangrim Mitsubishi and SAACKE Composite Maritime Boiler (CMB-VS), in both controlled laboratory conditions and real-world operational circumstances. Four types of fuel were tested: Heavy Fuel Oil (HFO), Marine Diesel Oil (MDO), Marine Gas Oil (MGO), and Liquefied Natural Gas (LNG). We measured CO_2, SO_x, NO_x, PM, and CO emissions, as well as fuel consumption levels.

Results & Discussion: LNG emitted the fewest pollutants, while HFO produced the most, particularly SO_x and PM. When used with LNG and MGO, the SAACKE CMB-VS model outperformed other models in terms of efficiency and emissions. The findings suggest that selecting the best fuel–boiler combinations can support compliance with pollution limits and increase operational sustainability.

Conclusion: The study infers that the use of cleaner fuels like LNG and advanced boiler systems such as the SAACKE CMB-VS can significantly reduce emissions in maritime operations. Future studies may concentrate on long-term operational costs and the incorporation of renewable energy sources into boiler systems to improve sustainability.

Keywords: Alternative fuels, Boiler efficiency, Emissions, International Maritime Organization, Marine boilers

Vulnerabilities and Resilience Protecting Modern Ships from Cyber Threats

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Introduction: The integration of advanced digital systems like GPS, Electronic Chart Display and Information Systems (ECDIS), Automatic Identification Systems (AIS), and engine management platforms has revolutionized maritime operations, enhanced efficiency, but exposed ships to cyber vulnerabilities. The maritime industry, historically focused on physical threats, now faces cyberattacks that jeopardize safety, cargo, the environment, and global trade.

Objectives: This study seeks to identify critical cyber vulnerabilities in shipboard systems, assess the effectiveness of existing resilience strategies, and propose actionable recommendations to enhance the maritime industry's cybersecurity posture, ensuring alignment with international regulations.

Methodology: A qualitative methodology was employed, integrating a literature review of maritime cybersecurity frameworks, analysis of cyber incidents from 2017–2024, and expert interviews with maritime cybersecurity professionals. Risk assessment tools categorized threats by severity and likelihood, and case studies of cyberattacks and mitigation strategies were analyzed to evaluate system resilience.

Results & Discussion: Findings indicate that outdated software, weak network architectures, and inadequate crew cyber awareness are primary vulnerabilities, resulting in navigation disruptions, communication failures, and compromised cargo data. Resilience strategies, including regular software updates, network segmentation, cyber drills, and onboard cybersecurity policies, mitigated risks by 25–35% in analyzed cases. However, inconsistent adoption across fleets and gaps in training and enforcement persist. The study underscores the need for standardized cybersecurity frameworks and continuous risk monitoring to counter evolving threats, in line with IMO guidelines.

Conclusion: Maritime cybersecurity demands a comprehensive approach, combining advanced technology, robust policies, and enhanced crew training. Resilience requires ongoing adaptation through automation, AI-driven threat detection, and regulatory compliance. Challenges include inconsistent implementation and resource limitations for smaller operators. Future research should explore scalable, cost-effective solutions and global standards to ensure robust cybersecurity, protecting maritime operations, crew, and the environment.

Keywords: Cyber vulnerabilities, IMO compliance, Maritime cybersecurity, Resilience strategies, Shipboard systems

Analysis of Engine Room Fires Caused by Fuel Leakages: Causes and Preventive Strategies

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Introduction: Engine room fires (over 60%) caused by fuel leaks pose serious risks to maritime safety, leading to financial, environmental, and human losses. Preventing such incidents is critical and must align with SOLAS and IMO safety guidelines.

Objectives: This paper will list the major factors that cause fire in engine rooms because of leakages of fuels and will suggest evidence based on the prevention mechanisms that lead to safety and environmental protection at sea.

Methodology: The methodology was mixed (qualitative analysis of incidents in 2019 - 2023 in industry reports, case studies, regulatory guidelines analysis across (SOLAS, IMO), and systematic literature review). Analysis was dedicated to the causes of fuel leakage, ignition, and preventative technology.

Results & Discussion: It was found that fuel spillage can be primarily due to failures of high-pressure piping and non-standard items, which ignite on hot metallic surfaces (>400 o C), such as turbochargers. There is a deterioration of risks that can be attributed to maintenance mistakes, like the absence of spray shields or the erosion of insulation. Such preventable steps as thermal imaging inspections, double-skinned piping, and crew training, as well as oil mist detection systems, significantly reduce the risk of fire, which is under IMO recommendations. These are viable, and have difficulties with uniform fleet application.

Conclusion: This paper presents practical solutions to maritime stakeholders on how to avoid engine room fires by fuel leakage, and this would enhance safety and regulation. Weaknesses are uneven maintenance procedures, and this is why universal standards should be considered. The next research should be aimed at considering sophisticated sensors and automated maintenance systems as a way to reduce risks further. The conclusions are beneficial as they offer viable ways of safeguarding lives, vessels, and surroundings.

Keywords: Engine room fires, Fuel leakages, Maritime safety, Preventive measures, SOLAS

Eco-Efficient Ballast Water Treatment for Bulk Carriers: An MCDM-Based Evaluation

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Introduction: Ballast water plays a vital role in maintaining ship stability and structural integrity during voyages. However, the untreated discharge of ballast water introduces invasive aquatic species into marine environments, leading to ecological imbalances and biodiversity loss. This study highlights the importance of selecting suitable Ballast Water Treatment Systems (BWTS) with a strong emphasis on minimizing environmental harm.

Objectives: The primary objective of this research is to evaluate and identify the most suitable BWTS for bulk carriers, considering environmental impact, energy efficiency, fuel consumption, and CO_2 emissions as key decision-making parameters.

Methodology: The study assesses seven BWTSs for an 83,000-deadweight tonne bulk carrier using two Multi-Criteria Decision-Making (MCDM) methods: the Analytical Hierarchy Process (AHP) and the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS). These methods facilitate the ranking and selection of optimal systems based on operational and environmental criteria.

Results & Discussion: Operational Expenditure (0.314508), Capital Expenditure (0.249515), and Capacity (0.159952) were identified as the most critical factors in selecting a BWTS. The analysis reveals that Product G (score: 0.8561137) is the most suitable among the seven evaluated. The selected system contributes 3% of total CO_2 emissions (456.5 tonnes), emphasizing the environmental impact of BWTS operations and the necessity for sustainable maritime practices.

Conclusion: The findings underscore the critical role of integrating environmental parameters in BWTS selection to support the maritime industry's sustainability goals. Future research should focus on innovative, eco-efficient treatment technologies that further minimize emissions and ecological harm.

Keywords: Analytical Hierarchy Process, Ballast water treatment, Bulk carriers, Carbon dioxide emissions, Environmental impact

Fire Prevention and Firefighting Strategies on Board Ships

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Introduction: Fire safety on ships is vital due to the confined nature of vessels and the presence of flammable substances like fuel, chemicals, and cargo. These conditions significantly increase the risk of fire incidents. Ensuring robust fire prevention and firefighting strategies is essential to protect human life and property at sea.

Objectives: This study aims to explore effective fire prevention techniques designed to reduce fire hazards on ships. Given the high-risk environment aboard vessels characterized by confined spaces, flammable materials, and complex machinery implementing proactive fire prevention measures is critical.

Methodology: This study was conducted as a comprehensive review of international maritime safety standards (IMO, SOLAS), onboard fire safety protocols, and best practices in shipboard fire prevention and firefighting. It integrates regulatory guidelines with practical onboard implementations and training protocols.

Results & Discussion: Major causes of shipboard fires, as identified in previous studies, include electrical faults, engine room malfunctions, improper cargo handling, and galley operations (IMO, 2017; EMSA, 2021). Key techniques include regular inspections and maintenance such as routine checks on electrical systems, fuel lines, and ventilation ducts as mandated by SOLAS Chapter II-2, Regulation 14, which emphasizes the importance of maintaining fire protection systems in full working order. Advanced early fire detection systems, particularly in engine rooms and galleys, have proven to reduce the likelihood of full-scale fires by 30% when using modern multi-sensor technology (DNV, 2022). Additionally, effective ventilation and compartmentalization help to control heat and limit the oxygen supply to fires.

Conclusion: Effective fire prevention and firefighting on ships depend on a combination of technological systems, preventive maintenance, regulatory adherence, and crew competency. Further improvements can be achieved through enhanced training programs and emerging fire detection technologies. These strategies ensure the continued safety of maritime operations and the protection of life and assets at sea.

Keywords: Crew training, Fire safety, Firefighting systems, Maritime safety, Shipboard fire prevention

Navigating Change: Cultural and Operational Barriers to Retrofitting Rotor Sails on Aging Bulk Carriers

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Introduction: The maritime industry produces approximately 3% of total greenhouse gases worldwide, fuel efficiency and reduction of emissions are a focus according to the IMO 2030/2050 roadmaps. Rotor sails and other Wind-Assisted Propulsion Technologies (WAPT) are gaining traction as they offer the potential to reduce emissions and fuel use by harnessing the wind and cutting the energy used to power vessels. Besides technical integration, there are also challenges for fitting rotor sails on old bulk carriers. This study examines the operational and cultural barriers preventing the integration of rotor sails into the modern day and how a holistic approach to implementation is essential is discussed.

Objectives: This study aims to examine the cultural and operational obstacles to installing rotor sails on older bulk carriers, while suggesting solutions to address these challengers and promote sustainable maritime practices.

Methodology: This study is qualitative in nature as it builds on the available literature on WAPT, evaluates the case studies of retrofitting initiatives, and interviews the maritime sector stakeholders, such as crew members, operators, etc. Operational disruption data, training deficiency data, and regulatory compliance data were gathered and astronomically combined to measure integration problems.

Results & Discussion: The results indicate the cultural barrier to the rotor sails in the form of lack of familiarity, training, and performance data. Among the operational issues are limited deck area, cargo interference and IMO/classification society regulations. Specific training, involvement of stakeholders and regulatory support are essential to justify the value and adoption.

Conclusion: Such obstacles can be overcome with better training, regulator cooperation, and multi-year measurement to enhance rotor sail integration. The contribution of this research to the maritime sector is that it will help to ensure sustainable operation, minimized emissions and future retrofitting.

Keywords: Cultural barriers, Maritime industry, Retrofitting, Rotor sails, Sustainability

Advancements in Condition-Based Monitoring and Smart Lubricating System for Marine Diesel Engines

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Introduction: Marine diesel engines operate under extreme conditions, making efficient lubrication essential for reducing wear, heat, and corrosion. To meet growing demands for efficiency and reliability, modern marine engineering is shifting toward intelligent lubrication systems.

Objectives: This review aims to evaluate the evolution and recent advancements in marine engine lubrication systems, particularly focusing on condition-based monitoring and smart lubricating technologies.

Methodology: This study adopted a review-based approach, synthesizing data from over 50 sources, including technical manuals, case studies, OEM manufacturer specifications, and peer-reviewed literature published between 2010 and 2024. The review covered both two-stroke and four-stroke marine diesel engines, focusing on lubrication system designs, oil types, monitoring methods, and automation technologies.

Results & Discussion: Modern marine lubrication systems vary by engine type, with 70% of two-stroke engines using quill-type cylinder lubrication and 30% adopting pulse systems, while four-stroke engines universally rely on sump-based circulation with 85% incorporating filtration and cooling. Trunk piston (four-stroke) engines typically use SAE 30–40 grade oils with TBN 10–15, whereas crosshead (two-stroke) engines require higher TBN oils (70–100) due to residual fuel use. A shift toward low-sulfur fuels has led 65% of sources to highlight a move to lower TBN oils. Oil condition monitoring, including viscosity, base number, and wear analysis, is emphasized in 92% of the literature, with 60% of vessels using onboard test kits and 40% of newer ships employing automated oil analysis systems.

Conclusion: Modern marine lubrication systems are shifting toward predictive, condition-based strategies. Innovations like synthetic oils, automated injection, and real-time sensors reduce wear, detect issues early, and minimize downtime. Future developments should focus on AI diagnostics and improved sensors to further extend engine life and enhance safety.

Keywords: Condition based monitoring, Lubrication systems, Predictive maintenance, Smart lubrication

Challenges of Incorporating Liquefied Natural Gas as an Alternative Fuel for Marine Engines in Place of Traditional Fuel Oil in the South Asian Region

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Introduction: Liquefied Natural Gas (LNG) is an emerging fuel alternative to traditional fuels like heavy fuel oils. A key reason for LNG incorporation in recent times is that it fits IMOs emission standards with relatively low emissions in comparison with fuel oils like HFO and other such traditional methods of combustion.

Objectives: The objective is to analyse the challenges of incorporating LNG as a viable marine engine fuel source in the. South Asian oceanic region.

Methodology: A multidisciplinary approach is used to assess the feasibility of LNG adoption in South Asia, drawing on literature reviews, infrastructure assessments, and environmental reports. The study evaluates technological readiness, economic viability, and regulatory frameworks, identifying gaps across the region. Case studies from Europe and North America are compared with South Asian examples to highlight key differences.

Results & Discussion: The adoption of LNG as a marine fuel in South Asia faces several challenges, including a limited LNG bunkering network with only eight major terminals, despite the region accounting for 27% of global trade. Regulatory inconsistencies across coastal states create obstacles for ship-owners, while weak enforcement mechanisms hinder compliance with IMO emission standards. The phenomenon of methane slip, with no specific regulations in South Asian countries, adds to environmental concerns. The lack of clear policies and infrastructure investment discourages stakeholders from transitioning to LNG, raising uncertainty about its feasibility as a widespread fuel alternative in the region.

Conclusion: The significance of these challenges lies in their direct impact on the feasibility of LNG as a sustainable marine fuel in South Asia. Without stronger policies, infrastructure expansion, and industry commitment, South Asia risks falling behind in the global push for cleaner maritime fuel alternatives, affecting both environmental progress and economic competitiveness.

Keywords: Emission standards, Marine alternative fuel

Enhancing Maritime Sustainability: The Role of Marine Engineering in Optimizing Voyage Planning and Ship Design

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Introduction: The shipping industry faces pressure to cut fuel use and emissions, with poor voyage planning a major cause of inefficiency. This study examines how marine engineering solutions, for example, like advanced tech and improved ship design, can optimize routing and support sustainable maritime operations.

Objectives: The primary objectives are to evaluate the role of marine engineers in improving voyage planning through data-driven technologies and to assess how ship design improvements, such as optimized hull structures, reduce fuel consumption and environmental impact.

Methodology: This mixed-methods study combined vessel performance data (2020–2024) with case studies of ships using advanced technologies. It examined navigation systems, engine monitoring tools, weather routing software, energy-efficient tech, and alternative fuels. Simulations assessed hull design impacts on wave and wind resistance, using industry reports and maritime databases.

Results & Discussion: Findings show that advanced navigation and weather routing tools can cut fuel use by up to 15%, while engine monitoring improves propulsion efficiency. Hull design upgrades reduced resistance by 10–12%, and technologies like waste heat recovery and LNG cut emissions by 20%. These results confirm the value of integrating engineering with voyage planning, though high retrofit costs and crew training remain challenges.

Conclusion: Marine engineering plays a pivotal role in enhancing voyage planning and ship design to achieve sustainability in the shipping industry. By leveraging data-driven technologies and optimizing hull structures, engineers can significantly reduce fuel consumption and emissions. Limitations include the scalability of advanced systems across diverse fleets and the need for industry-wide standards. Future research should focus on cost-effective retrofitting solutions and the integration of AI-driven voyage optimization tools. These findings benefit the maritime sector by providing actionable strategies for operational efficiency and supporting global sustainability goals.

Keywords: Emission reduction, Maritime sustainability, Ship design, Voyage planning

Addressing the Invisible Burden of Loneliness Among Seafarers

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Introduction: Seafarers are essential to global trade but face ongoing personal challenges, especially mental health issues. Social isolation from long absences, limited internet, restricted leave, and cultural barriers contribute significantly to their well-being concerns.

Objectives: Goal(s) The primary goal is to encourage productive and positive work output from satisfied and content seafarers worldwide. This study also seeks to shed light on how to deal with social isolation while working aboard ships.

Methodology: Semi-structured interviews will be conducted with a smaller, diverse subsample of seafarers to gather qualitative data. These interviews will explore their personal experiences with social isolation, coping mechanisms, perceived impacts on well-being, and suggestions for improvement. Depending on feasibility, interviews will be conducted either virtually or in person, with strict measures in place to ensure confidentiality.

Results & Discussion: Our research is expected to show that many seafarers feel lonely and isolated, leading to higher stress, anxiety, and job dissatisfaction. Surveys and interviews will likely reveal key causes, such as time away from family, limited internet, and constant interaction with the same crew, worsened by language and cultural differences. Some seafarers may feel more isolated depending on their role or ship type. These findings highlight loneliness as a serious threat to seafarers' mental health.

Conclusion: In conclusion, it is critical to address the invisible burden of social isolation and loneliness among seafarers to protect their well-being and preserve a successful international trading network. Their mental health is greatly impacted by the demanding nature of their work, as well as by cultural barriers and a lack of connectivity. We can accomplish the goal of creating a happier and more productive seafaring workforce globally by concentrating on tactics that reduce social isolation, such as better internet access, increased shore leave opportunities, and culturally sensitive crew interactions.

Keywords: Coping mechanisms, Cultural barriers, Maritime industry, Maritime workforce, Occupational stress, Workplace wellbeing

Impacts of Autonomous Vessels and AI-Driven Predictive Maintenance on Maritime Operational Efficiency and Sustainability

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Introduction: Technological advancements are reshaping the maritime industry, with autonomous vessels and Artificial Intelligence (AI) - based predictive maintenance gaining traction. These innovations aim to improve navigational safety, reduce environmental impact, and optimize operational performance, addressing global demands for greener maritime operations.

Objectives: This study aims to evaluate how autonomous navigation systems and AI-driven predictive maintenance enhance operational efficiency and sustainability within maritime operations, and to assess the challenges that may hinder their widespread adoption.

Methodology: The study employs a qualitative approach by analyzing secondary data from industry reports, academic literature, and case studies, such as the Yara Birkeland project and AI-based route optimization systems. Key performance indicators assessed include fuel efficiency, operational downtime, and emission reduction.

Results & Discussion: Findings suggest that autonomous vessels can reduce human error-related incidents by up to 75%, improve voyage planning efficiency by 15–20%, and contribute to fuel savings of 10–12%. Predictive maintenance technologies enable early fault detection, leading to a 30–40% reduction in unplanned downtime and 20–25% savings in repair costs. Combined, these innovations help lower carbon emissions by approximately 10%, significantly enhancing voyage efficiency. However, widespread adoption faces challenges, including regulatory uncertainties, cybersecurity vulnerabilities, and high integration costs, which can exceed USD 3–5 million per vessel. Despite these barriers, the research indicates a strong trajectory toward sustainable shipping, provided that these issues are proactively addressed.

Conclusion: The integration of autonomous and AI-driven systems presents substantial potential for revolutionizing maritime operations. For broader adoption, clear regulatory frameworks and cybersecurity protocols must be established. Future research should focus on pilot implementations and cross-disciplinary collaboration to bridge technological and institutional gaps in the maritime sector.

Keywords: Autonomous vessels, Maritime efficiency, Predictive maintenance, Sustainability

Refrigerant-Based Waste Heat Recovery for Ships: A Thermodynamic Comparison with ORC Systems

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Introduction: Waste Heat Recovery (WHR) systems in marine applications commonly reclaim only a fraction ($4-9\%$) of the energy from Diesel propulsion systems. Conventional methods such as Organic Rankine Cycles (ORC), steam cycles, absorption chillers, and other hybrid configurations offer partial solutions, but face challenges in modularity, integration flexibility, and end-use versatility. This study investigates an alternative refrigerant-based WHR configuration aimed at more adaptable and efficient onboard energy utilization.

Objectives: The main objective is to evaluate the feasibility and performance of a novel refrigerant-based WHR loop that recovers waste heat from both exhaust gas and jacket water for integrated thermal and electrical applications on ships.

Methodology: A comparative thermodynamic analysis was conducted, benchmarking the proposed refrigerant-based loop against conventional ORC systems. Performance metrics such as fuel savings, Coefficient of Performance (COP), and exergy efficiency were modeled under varying load conditions. The system was assessed for its ability to support heating, cooling, and electricity generation functions.

Results & Discussion: The integrated system demonstrated fuel savings in the range of $5-9\%$, comparable to or exceeding ORC benchmarks. COP values for HVAC cooling ranged between $2.2-4$, with potential exergy efficiencies surpassing 60%. The refrigerant-based design also improved modularity and deployment flexibility, offering a practical path to multi-functional energy recovery in constrained shipboard environments.

Conclusion: Theoretical analyses affirm the viability of the proposed WHR loop, suggesting it can outperform conventional solutions in efficiency and integration. These findings warrant further development through prototype testing and onboard trials to validate its practical performance and economic benefits.

Keywords: Energy efficiency, Organic Rankine Cycle, Refrigerant loop, Waste heat recovery

The Impact of Ship Noise on Seafarers: Investigating Hearing Impairments, Cognitive Function Decline, Sleep Disturbances, and Daily Operational Challenges

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Introduction: This research investigates the effects of ship noise on seafarers, specifically focusing on hearing loss, cognitive decline, sleep problems, and associated daily operational difficulties. The continuous high levels of noise onboard vessels, originating from engines, machinery, and operational activities, pose significant health and safety implications for maritime workers.

Objectives: This study aims to investigate the health and operational impacts of ship noise on seafarers, specifically examining noise-induced hearing loss, cognitive function decline, and sleep disturbances.

Methodology: This study will employ a mixed-methods approach. It will involve a comprehensive literature review to explore existing data and research regarding ship noise levels and their effects on seafarer health. Furthermore, primary data will be collected through an online survey administered to seafarers. The survey will gather insights into seafarers' experiences with ship noise, its perceived impact on their hearing, cognitive function, sleep quality, and daily operational performance.

Results & Discussion: The findings of this study are expected to highlight the urgent need for more stringent noise control measures and regulatory reforms within the maritime industry. A critical analysis will be provided regarding the disparity between WHO recommended noise levels of under 40 dB(A) for healthy sleep and the significantly higher limits currently set by the International Maritime Organization (IMO) [60 dB/55 dB].

Conclusion: This research aims to emphasize that reforms are crucial to address existing knowledge gaps and enhance labor protection for seafarers. The outcomes of this study will benefit the scientific and academic community by providing comprehensive insights into the health impacts of ship noise and guide future research and policy development in maritime occupational health and safety.

Keywords: Cognitive decline, Hearing loss, Noise control, Occupational health, Seafarer health

Connected but Exposed – Cyber Risks on the High Seas

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Introduction: Modern ships rely on digital systems for navigation, engines, cargo, and monitoring, boosting efficiency but increasing cyber threats. This rising connectivity poses growing risks to maritime safety and global trade.

Objectives: This paper examines rising cyber threats to modern ships and highlights the urgent need for stronger cybersecurity in the maritime sector. It underscores the risks of digital connectivity and outlines practical measures the industry can adopt for protection.

Methodology: This analysis draws on real-world incidents and industry practices, such as the NotPetya attack on Maersk and GPS spoofing in the Black Sea, to reveal cybersecurity gaps in ship systems not originally designed with digital threats in mind. It also reviews IMO guidelines to identify best practices. The study is literature-based, focusing on documented case studies, regulatory frameworks, and academic research.

Results & Discussion: Evidence shows that maritime systems often use outdated software, weak passwords, and lack strong network protection, making them vulnerable to cyberattacks. Incidents like Maersk's $300 million loss and GPS spoofing show the risks to operations and safety. Cybersecurity requires layered defenses, including trained crew, strong protocols, and adherence to international standards with regular response testing.

Conclusion: Being connected is now essential in shipping, but being secure must be just as important. The maritime industry can no longer afford to treat cybersecurity as an afterthought. By combining better technology, smarter training, and global cooperation, we can protect not just ships and cargo, but also the people and economies that depend on them. Cyber risks may be invisible, but their impact is very real, and the time to act is now.

Keywords: Maritime cybersecurity, Ransomware, Remote monitoring, Spoofing

Sewage Treatment and Wastewater Management Systems on Ships: Advancements, Compliance, and Efficiency

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Introduction: Untreated sewage discharge from ships harms marine ecosystems by spreading pathogens and increasing nutrient loads. MARPOL Annex IV now enforces strict regulations, requiring ships to install efficient, compact treatment systems.

Objectives: This research aims to evaluate the effectiveness, operational efficiency, and regulatory compliance of contemporary shipboard sewage and wastewater treatment technologies, including membrane bioreactors (MBRs), chlorination, and UV disinfection.

Methodology: Data were collected from technical reviews, field studies, and ship reports, focusing on integrated sewage treatment systems, including advanced sludge and compact MBR units. Innovations like updated settling tanks and pump alarm sensors were noted. Sewage output averaged 100–120 liters per crew member daily, while freshwater systems provided 20,000–50,000 liters per day, depending on ship type.

Results & Discussion: Primary treatment removes up to 60–70% of suspended solids through screening and sedimentation. Secondary processes, including biological filtration and activated sludge, reduce Biochemical Oxygen Demand (BOD) by 85–90%. MBR systems offer effluent of exceptionally high quality, achieving pathogen removal efficiency exceeding 95%, albeit with higher energy demands. UV disinfection, while chemical-free, is susceptible to water turbidity, whereas chlorination presents risks of byproduct formation. System performance varies based on vessel type, space constraints, and maintenance regimes. Managing daily sewage volumes between 2,000–6,000 liters for typical crew sizes necessitates robust, reliable systems supported by sufficient freshwater generation.

Conclusion: Modern sewage treatment systems on ships have evolved to meet strict international standards. While MBRs and UV systems offer high-quality treatment, trade-offs in cost and maintenance exist. Future advancements should focus on energy-efficient, low-maintenance solutions adaptable to diverse maritime environments. Properly scaled systems addressing actual sewage generation and freshwater availability are critical to ensure sustainable marine operations and regulatory compliance.

Keywords: Marine pollution, Sewage management, UV Disinfection, Wastewater treatment

Marine Engine Emissions and Environmental Regulation

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Introduction: Marine diesel engines are essential to global transport but are major sources of nitrogen oxides (NO_x), sulfur oxides (SO_x), and greenhouse gases (GHGs) from marine engines. To address this, IMO introduced MARPOL Annex VI to curb ship-related air pollution. Battery-powered propulsion offers a cleaner alternative to traditional fossil fuels.

Objectives: The primary objective of this research is to explore technological advancements, particularly battery-electric propulsion systems, that aim to reduce atmospheric emissions from marine vessels, and to identify and address the challenges associated with their implementation.

Methodology: This study is based on a review of recent literature, case studies (such as the MV Yara Birkeland), and existing IMO environmental regulations. Data regarding emission levels, energy efficiency, and operational costs of traditional and electric-powered vessels were analyzed to understand the feasibility of transitioning to cleaner technologies.

Results & Discussion: Battery-electric power has emerged as a promising solution to reduce emissions in the maritime industry. Fully electric and hybrid vessels, such as the MV Yara Birkeland, demonstrate the viability of this technology. However, challenges such as high installation costs, limited energy density of batteries, charging infrastructure, and onboard storage requirements pose significant barriers. Proposed solutions include the integration of renewable energy sources like solar panels for recharging, which can enhance efficiency and lower operational costs. The shift to electric propulsion offers long-term environmental and economic benefits, though widespread adoption requires substantial investment and technological support.

Conclusion: While battery-electric marine propulsion presents clear environmental advantages, several challenges must be addressed to facilitate widespread adoption. Future research should focus on improving battery technology, developing cost-effective renewable charging methods, and enhancing infrastructure. The outcomes of this research are valuable for shaping sustainable practices in the maritime industry and supporting global efforts to combat climate change.

Keywords: Battery electric ships, Environmental regulation, Marine emissions, Sustainable shipping

Comparative Study of Cooling System Failures in Diesel and LNG-Powered Marine Generators

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Introduction: To boost efficiency and cut emissions, the marine industry is turning to dual-fuel systems using diesel and Liquefied Natural Gas (LNG). LNG gensets need cryogenic cooling, while diesel units face issues like carbon buildup and low oil pressure. Understanding these differences is key to safe, reliable operations.

Objectives: The purpose of this research is to analyze cooling system failures in cargo ship diesel and LNG gensets, pinpoint the underlying reasons for these failures, and assess maintenance procedures to improve operational dependability.

Methodology: Over a year, information about the state of the cryogenic system, combustion temperatures, and lubricating oil pressure was gathered from sensor outputs, maintenance logs, and operational logs. Documentation was kept of maintenance procedures like oil line purging, sensor replacements, and cryogenic seal examinations. The frequency, reasons, and efficacy of maintenance were the key topics of the comparative analysis.

Results & Discussion: Diesel gensets often faced oil pressure drops below 3.0 bar during sudden load changes, leading to overheating and shutdowns. Carbon buildup from incomplete combustion worsened cooling issues, and maintenance rarely restored ideal pressure levels. In contrast, LNG gensets had fewer cooling failures due to lower combustion temperatures and pressures but required strict cryogenic monitoring to prevent leaks below -150°C. The findings show diesel issues are mainly mechanical and combustion-related, while LNG concerns focus on cryogenic safety. Tailored maintenance is essential for reliable operation.

Conclusion: LNG gensets need cryogenic maintenance, while diesel gensets require regular checks for pressure and carbon buildup. Future research should focus on predictive maintenance and advanced monitoring to reduce downtime and improve safety. This study not only offers practical guidance for marine engineers but also highlights the critical role of targeted maintenance strategies in ensuring safer, more sustainable, and more efficient dual-fuel marine operations.

Keywords: Carbon deposits, Cooling system failure, Cryogenic systems, Lubricating oil pressure

Faculty of Science

Development of Paper-based Colorimetric Biosensor for Rapid, Equipment-Free Detection of C-Reactive Protein using *Clitoria tarnatea* Anthocyanin, Curcumin, or Betalains

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Introduction: C-Reactive Protein (CRP) is a critical biomarker for inflammation and infection, but current detection methods are costly and require laboratory infrastructure. This study aims to develop a low-cost, paper-based colorimetric biosensor using natural plant pigments to enable rapid, equipment-free CRP detection, especially in resource-limited settings.

Objectives: To fabricate a paper-based biosensor with hydrophobic barriers, utilize natural chromogens (butterfly pea, curcumin, betalains) for CRP detection, and evaluate its sensitivity and specificity against standard methods.

Methodology: Microfluidic channels were patterned on chitosan-coated filter paper using paraffin wax. Natural chromogens were extracted and conjugated with anti-CRP antibodies, then immobilized on detection zones. Serum samples were applied, and CRP binding induced a color change (e.g., blue to pink with anthocyanins at >5 µg/mL CRP). Color intensity was quantified using smartphone imaging and compared with turbidimetric assays. Calibration and validation were conducted using synthetic and clinical samples.

Results & Discussion: The biosensor reliably detected CRP at the clinical threshold of 5 µg/mL, with sensitivity and specificity comparable to standard assays. Results were available within 15 minutes, and the device remained stable under local climate conditions. Smartphone-based quantification closely matched laboratory results, confirming its suitability for rapid, low-cost screening. The primary challenge identified was sourcing anti-CRP antibodies, critical for consistent biosensor performance.

Conclusion: This natural pigment-based paper biosensor offers a rapid, affordable, and accessible tool for CRP detection. Addressing antibody acquisition challenges and further clinical validation are essential for broader application. The biosensor has potential to improve healthcare accessibility in rural communities.

Keywords: Anthocyanins, C-Reactive Protein, Colorimetric detection, Paper-based biosensor, Point-of-care diagnostics

Development of Tomato Sauce using Selected Tomato Varieties in Sri Lanka with Alternative Two Thickening Agents and Analysis of Proximate and Sensory Characteristics

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Introduction: Tomato sauce is an easy, convenient and widely consumed condiment as toppings and elevating the flavor. Its quality is significantly influenced by the thickening agent used during the preparation stage.

Objectives: To determine the most suitable tomato variety and starch for producing high quality and consumer acceptable tomato sauce.

Methodology: Three tomato varieties (Padma, Nanda, Valoura), were selected and assessed their suitability for sauce preparation from total soluble solid, acidity like parameters. Tapioca and arrowroot starch were used as alternative thickening agents with nine formulations, tapioca starch (w/w) containing samples as 1% (C_2), 1.5% (C_3), 2% (C_4), arrowroot starch containing samples as 1% (H_2), 1.5% (H_3), 2% (H_4) and combination of both starches as 1% (CH_2), 1.5% (CH_3), 2% (CH_4).

Results & Discussion: This revealed that the using arrowroot, tapioca and combination of both (1 :1) starches, significantly impacted the physicochemical properties of sauce, including pH, total soluble solid and viscosity. Arrowroot starch resulted in higher viscosity (1175.34 ± 7.98 Pa·s) and shear stress (28.56 ± 0.1 Pa), leading to a thicker sauce, whereas tapioca starch yielded a thinner but smoother texture (27.83 ± 0.3 Pa). Among the samples, the best formulations were 1.5%w/w of tapioca starch, 1.5%w/w of arrowroot starch, and 2%w/w of 1:1 combination of both starches. CH_4 demonstrated the moderate viscosity (1093.43±6.72^b Pa·s) and vibrant color (L* = 10.79). Arrowroot starch provided superior swelling properties (3.4667 ± 0.15), water absorption capacity (1.92 ± 0.06 g/g), high gelling temperature (78^{0}C-82^{0}C) and less glossy appearance than the tapioca starch. Sensory evaluation highlighted sample CH_4 as the most preferred. The TPC remained at a microbiologically safe level during 3 weeks of storage (< 300CFU).

Conclusion: The Padma variety with CH_4 starch yielded optimal tomato sauce properties, showing CH_4's potential as an alternative thickener for quality, consumer-accepted products.

Keywords: Arrowroot starch, Nanda, Valoura and Padma tomato varieties

Enhancing Functional and Mechanical Properties of Cellulose Nanofiber-based Thin Films from Renewable Biomass for Sustainable Packaging Solutions

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Introduction: This study investigates Cellulose Nanofiber (CNF) films derived from renewable biomass, reinforced with PVA, to develop eco-friendly packaging materials with improved flexibility and mechanical performances.

Objectives: To enhance the film-forming ability and mechanical performance of rice straw/water hyacinth-derived CNF by incorporating PVA as a plasticizer, thereby producing composite films suitable for sustainable packaging applications.

Methodology: The tensile strength and elongation at break of composite films prepared with varying PVA concentrations (0.6%, 0.8%, 1%) were systematically evaluated. Additionally, their bending rigidity, transparency, thickness, water solubility, and water absorption ability were assessed to comprehensively characterize the performance and suitability of the composite films for sustainable packaging applications.

Results & Discussion: The results demonstrated a clear improvement in the mechanical properties of the CNF-based thin films with the incorporation of increasing concentrations of PVA. The elongation at break increased with the increasing PVA concentrations (7.5%, 11.3%, and 15.8%), while the tensile strength slightly decreased (95.6 MPa, 88.3 MPa, and 79.2 MPa), respectively. Compared to existing CNF-based films in the literature, where pure CNF films often exhibit high tensile strength but low flexibility, the composite film fabricated in this study demonstrates a balanced enhancement of both mechanical and functional properties. The uniform distribution of PVA within the CNF matrix is accountable for the significant ($p<0.05$) improvement in the transparency and thickness of the films.

Conclusion: Increasing the PVA concentration in the CNF-based thin films enhanced their mechanical performance and water-related properties, confirming their suitability for eco-friendly packaging applications over conventional plastic packaging solutions.

Keywords: Biomass-derived CNFs, Mechanical properties, Packaging films, Sustainability

Development of Jackfruit Rind Flour Incorporated String Hopper Flour Mixture

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Introduction: Jackfruit rind, generally considered a waste, is rich excellent source of fiber, minerals and antioxidants.

Objectives: This study aimed to develop a string hopper flour mixture by incorporating jackfruit rind flour into sudu kekulu rice flour to improve fiber content, flour properties such as swelling capacity, water absorption capacity, oil absorption capacity, gelatinization temperature, and loose bulk density, and reduce the solid waste of jackfruit.

Methodology: Jackfruit rind flour was blended with sudu kekulu rice flour at 5%, 10%, and 15% ratios to create a composite flour. String hoppers were prepared, and the best formulation was selected using a 5-point hedonic sensory test. The flour's proximate, physicochemical, and techno-functional properties, along with the textural and sensory qualities of the string hoppers, were analyzed.

Results & Discussion: Jackfruit rind flour had significantly higher fiber content (4.90%) than rice flour (0.33%). The composite flour had higher mineral (0.93%) and fat (1.81%) content compared to rice flour (0.46% and 0.93%). Its moisture content (12.67%) was slightly lower than rice flour (12.85%). The swelling capacity of composite flour (1.96 mL/g) was significantly higher than rice flour (1.16 mL/g). Incorporating jackfruit rind flour increased rice flour's water absorption capacity by 5.56%, while oil absorption capacity decreased by 27.20%. The composite flour gelatinized at 80°C, compared to 96°C for rice flour. Loose bulk density was also higher in composite flour (0.82 g/mL) than rice flour (0.70 g/mL). No significant differences were found in hardness (rice flour: 30.40 ± 0.25 g; composite flour: 30.55 ± 0.30 g) and adhesiveness (rice flour: 0.11 ± 0.01 mJ; composite flour: 0.12 ± 0.01 mJ) of string hoppers made with both flours, based on triplicate samples.

Conclusion: The incorporation of jackfruit rind flour up to 15% (w/w%) was the best in making string hopper flour, while valorizing the waste.

Keywords: Fiber, Jackfruit rind, Rice flour, String hoppers, Textural properties

Effect of Maturity Stages and Ripening Stages on the Textural, Flavour and Colour Quality of Dehydrated Organic TJC Mangoes *(Mangifera indica L.)*

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Introduction: Dehydrated Totapuri Jamadar Collection (TJC) mangoes are a popular value-added food. However, pre-processing factors such as maturity and ripening stages significantly affect the quality of the final product.

Objectives: The aim was to assess the impact of harvest maturity and ripening stages on the physicochemical, textural, nutritional, microbial and sensory properties of dehydrated organic TJC mangoes and to develop a quality matrix for optimal processing.

Methodology: TJC mangoes were harvested at three maturity stages (early, mid and full) and ripened to three levels (partially ripped, fully ripped and overripped) to analyse for yield nine combinations. The slices ($\approx$ 1 cm thickness) were dehydrated at 60°C using a forced convection oven until they achieved 12-14% moisture content. The samples were analysed for physicochemical properties such as pH, texture profile, colour, antioxidant activity (using DPPH assay), microbial activity and sensory properties.

Results & Discussion: Ripening stage was significantly affected by moisture (11.05–14.44%), water activity (0.643–0.787), acidity (1.02–0.60%) and pH. The carotenoid content of fully matured overripped samples reached a maximum of 5.06mg/100g and showed the highest antioxidant activity (IC_{50} = 26.8 ppm). Texture profile analysis showed a decrease in firmness and chewiness during ripening from 236.8g (early-partially ripped) to 33.12g (fully-overripped). All samples were found within the microbial safety limits. A maturity-ripening-quality matrix was developed based on normalized texture and colour scores, it ranges from a total score of 0.246 (fully-overripped) to 0.754 (early-fully ripped). This matrix provides a practical reference for selecting appropriate harvesting and ripening stages in mango processing.

Conclusion: Full matured and full ripped combination has been identified for the production of high quality dehydrated TJC mangoes. The developed matrix can guide processors in selecting the ideal pre-processing stages.

Keywords: Colour analysis, Dehydrated TJC mangoes, Maturity stages, Ripening stages, Texture profile analysis

Diversity and Richness of Benthic Macro-Invertebrates in Relation to Water Quality Parameters of Selected Reservoirs in Southern Province, Sri Lanka

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Introduction: Macrobenthic diversity and richness are important bio-indicators of quality of aquatic-ecosystems.

Objectives: The study explored how water quality and sediment traits influence macrobenthic diversity and richness in eight Southern Province reservoirs of Sri Lanka: Ridiyagma, Urusita, Mahagal, Kiribban, Maha Aluthgamara, Weerawila, Maha Wewa, and Handapaanagala Wewa.

Methodology: Between September and November 2023, key water parameters—dissolved oxygen, sediment organic content, salinity, resistivity, conductivity, pH, temperature, and redox potential—were measured in the reservoirs. Core samples (5 cm × 15 cm) were collected from three sites per lake on two visits with triplicates. Macrobenthic diversity was assessed using Shannon–Wiener, Simpson, BMWP, richness, and evenness indices, and correlations were analyzed with IBM SPSS 25 and R 4.3.2.

Results & Discussion: Species richness (S) correlated positively with H′ (r = 0.81), D (r = 0.93), and BMWP (r = 0.94), but negatively with dissolved oxygen (DO) (r = –0.31) and D50 particle size (r = –0.22) (all p < 0.05). DO showed no significant links to H′, D, BMWP, or ASPT. D50 was negatively correlated with H′ (r = –0.13), D (r = –0.27), and BMWP (r = –0.45) (all p < 0.05). D correlated positively with H′ (r = 0.83) and BMWP (r = 0.87), while H′ and BMWP were also positively related (r = 0.72) (all p < 0.05).

Conclusion: The study found that water quality and sediment characteristics strongly influence macrobenthic diversity. Higher sulfur levels correlated with finer sediments and stable conditions, while elevated dissolved oxygen caused stress that reduced species diversity, especially in polluted waters. Overall, macrobenthic communities proved valuable indicators of freshwater ecosystem health and water quality.

Keywords: Bio-indicator, Macrobenthos, Richness, Species diversity, Water quality

Evaluation of the Knowledge on Genetically Modified Food in a Cohort of Undergraduates in Sri Lanka

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Introduction: Genetic modification alters the genome of an organism by introducing genes from another organism. When applied to food, the resulting products are named Genetically Modified (GM) foods. As global consumption of GM food increases, raising public awareness is vital in countries such as Sri Lanka, where their use remains limited.

Objectives: The primary objective of this study was to evaluate the level of knowledge regarding GM foods among a cohort of Sri Lankan undergraduates.

Methodology: An online questionnaire with closed-ended questions on GM food was distributed to a cohort of Sri Lankan undergraduates (n = 101), using simple random sampling via social media platforms. Undergraduates were selected for this study as they represent an educated segment of the population that can influence future consumer behavior and policy decisions. The questionnaire assessed knowledge of GM food types, production processes, benefits, potential health and nutritional effects, labelling, and local/regional GM food availability. Responses were scored out of 30 using a predefined marking scheme. The mean score was calculated as a percentage and analyzed using a right-tailed one-sample t-test against a threshold of 74.99% (equivalent to 22.50/30). The null hypothesis stated participants had poor-to-average knowledge ($\leq 74.99\%$), while the alternative hypothesis suggested otherwise (>74.99%).

Results & Discussion: The mean score of the cohort was 14.33 out of 30 (47.77%). The calculated t-statistic was -16.99, which did not exceed the critical value of +1.660 (df = 100, α = 0.05). Therefore, the null hypothesis could not be rejected, indicating poor-to-average knowledge of GM food among the cohort.

Conclusion: Current study highlights a need to enhance GM food knowledge among Sri Lankan undergraduates. Improved understanding within this group may support future acceptance and development of GM food in Sri Lanka. Future research using open-ended questions is recommended for deeper insights.

Keywords: Genetically modified food, Knowledge evaluation, Sri Lanka, Undergraduate students

A Novel Hybrid Processed Cheese Fortified with Black-Eyed Pea *(Vigna unguiculata)*: Impact on Sensory Attributes and Consumer Acceptability Compared to Conventional Cheese

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Introduction: The dairy industry's high greenhouse gas emissions drive the need for sustainable, cost-effective food alternatives. Fully plant-based cheeses often lack the sensory appeal consumers expect, while hybrid cheeses partially replace dairy with plant ingredients offer a viable solution. This study evaluates the sensory and consumer acceptability of black-eyed pea-fortified hybrid processed cheese as a step toward commercial viability and supporting the sustainable food transition.

Objectives: To formulate hybrid processed cheese using black-eyed pea, and evaluate sensory, and consumer acceptance compared to a conventional cheese.

Methodology: Hybrid processed cheese was produced by incorporating black-eyed pea pulp into semi-hard Gouda cheese. Two formulations (25% and 30%) were developed Sensory analysis was conducted with 30 untrained panelists using a 9-point hedonic scale. Just-About-Right (JAR) scaling, Check-All-That-Apply (CATA) for attributes and emotions, buying frequency tests were used to analyze consumer perception and Friedman test determined statistical differences in overall liking.

Results & Discussion: The 30% formulation achieved higher scores for flavor (7.4), texture (7.7), and overall acceptability (7.2), showing no significant difference from the resemble cheese ($P>0.05$), whereas the 25% variant was rated lower ($P<0.05$). JAR analysis indicated greater sensory alignment for the 30% sample. CATA results associated it with favorable descriptors like "creamy," "chewy," and "cheesy," and positive emotions such as "happy" and "satisfied." Buying frequency for the 30% formula (22%) was higher than the 25% (18%), though slightly lower than the resemble cheese (27%), indicating good market potential.

Conclusion: The 30% black-eyed pea incorporated hybrid cheese matched the sensory appeal of conventional cheese, with superior consumer perception compared to the 25% variant. These findings support its potential for commercial development as a cost-effective and sustainable alternative. Further optimization of texture and color could enhance its consumer appeal.

Keywords: Palatability, Preference, Semi hard cheese, Sustainable, Texture

"Research is creating new knowledge."
- Neil Armstrong -

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