ISSUE 01 - APRIL 2025

GLOBAL CONFERENCE FOR MULTIDISCIPLINARY RESEARCH

GCMR 2025

BRIDGING THE GAP

Leveraging Emerging Technologies for Sustainable Development in the Global South

Achievers International Campus

Vision

To be the best national provider of educated and skilled professionals to the global knowledge economy.

Mission

The global Sri Lankan, building a knowledge based network, eliminating digital poverty, creating individuals and making professionals in the knowledge based society to satisfy the global demand for knowledge workers.

GLOBAL CONFERENCE FOR MULTIDISCIPLINARY RESEARCH GCMR 2025

ACHIEVERS INTERNATIONAL CAMPUS

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Subject Disclaimer

The content presented in this symposium book is the result of open research contributions from participants across Sri Lanka. The views, findings, and opinions expressed in the individual papers are those of the respective authors and do not necessarily reflect the official stance or policy of Achievers International Campus.

This symposium aims to foster knowledge-sharing and academic exploration. While every effort has been made to ensure the accuracy and credibility of the research presented, the organizers cannot guarantee the completeness or accuracy of the information included.

By participating in this event, all authors and attendees acknowledge that the presented research is for academic and educational purposes only, and any actions taken based on the information provided are the responsibility of the individual.


Achievers
International
Campus

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About Achievers International Campus

Achievers International Campus is a premier private sector higher education institute in Sri Lanka. Achievers International Campus maintains a high level of quality and excellence in education. From its inception Achievers International Campus has had a long term vision of contributing effectively in its capacity towards a knowledge based society

The secret behind this legendary company has always been passionate workmanship. At Achievers International Campus it is always about Innovation, Professionalism at work, and proceeding towards Excellence. The dedication from the bottom up hierarchy has taken Achievers International Campus to greater heights.

The Achievers International Campus provides education and training in ICT, Business and many other fields. We now offer over 150 different study programmes in a number of different fields. Our choices of programmes span from Foundation to Doctoral level programmes.

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Partners

The University of Gloucestershire is a Public University based in Gloucestershire, England. With its commitment to high quality degrees, teaching and research, the University of Gloucestershire has delivered academic excellence since 1847. The University provides almost 100 undergraduate courses and around 57 taught postgraduate courses, covering a variety of subjects including Accounting, Law, Business Management, Computing, Journalism, Fine Art, Humanities, Biology, Geography, Social Science and Education. Achievers International Campus is the only partner institution offering University of Gloucestershire degree and postgraduate programmes to Sri Lankan students.

The University of Wolverhampton is a public university in England with a history of nearly 200 years, originating from the Wolverhampton Tradesmen's and Mechanics' Institute. It offers a wide range of undergraduate and postgraduate courses across its three faculties: Arts, Business & Social Sciences, Education, Health & Wellbeing, and Science & Engineering. The university is known for its focus on practical, hands-on learning, industry links, and research excellence. It has four main campuses in the Midlands, including City Campus in Wolverhampton, and is recognized for its strong graduate employability rate.

The University of Portsmouth is a modern, public university located on the south coast of England. It's known for its strong focus on practical, career-focused courses and high student satisfaction, with many undergraduate programs including a year-long paid work placement. The university has a strong reputation in areas like geology, pharmacy, and engineering, and is recognized for its research power.

The Tunku Abdul Rahman University of Management and Technology is a non-profit, private university in Malaysia. Named after the country's first prime minister, Tunku Abdul Rahman, the school was founded in 1969 as Tunku Abdul Rahman College by the Malaysian Chinese Association. "A premier institution of higher learning in Malaysia. Providing quality tertiary education and opportunities beyond academic knowledge and skills since 1969. TAR College (TARC) (1969 - 2013) TAR University College (TAR UC) (2013 - 2022) TAR UMT (2022 onwards)"

IIC University of Technology came into existence in 2008 through the evolution of the International Institute of Cambodia, founded in 1999. IIC University is accredited by the Royal Government of Cambodia as specified in Sub-Decree No. 127ANK.BK. It is a member of the International Association of Universities .

Pearson is UK's largest awarding organisation offering academic and vocational qualifications in schools, colleges and work places in the UK and abroad. Their qualifications include Edexcel NVQ and BTEC from entry level to Higher National Diplomas (HND). It is recognized in more than 70 countries worldwide. Achievers International Campus has a longstanding partnership with Pearson and currently offers the BTEC HND Programmes in the fields of Computing, Business and Engineering.

OTHM Qualifications is an awarding body regulated by Ofqual (Office of the Qualifications and Examinations Regulation) in England. OTHM offers a wide range of Management and Leadership qualifications within a variety of professional contexts all of which are delivered through approved centres globally.

Message from Chairman

Manimaran Maheswaran

Chairman, Achievers International Campus

> It is with great pleasure that I warmly welcome all presenters, researchers, and participants to the Global Conference for Multidisciplinary Research (GCMR) 2025, organized by Achievers International Campus in Dehiwala, Sri Lanka.

"Research is creating new knowledge." Neil Armstrong.

This simple yet profound truth reminds us why we gather here today: to push the boundaries of understanding, foster innovation, and pave the way for a better tomorrow. The theme for this year's conference, "Leveraging Emerging Technologies for Sustainable Development in the Global South," is both timely and significant. As the world embraces rapid technological change, it is imperative that we focus on how these innovations can be harnessed to drive sustainable growth, especially within the Global South. Our collective efforts through research and collaboration will be key in building resilient, inclusive, and sustainable futures.

At Achievers International Campus, we believe in the power of multidisciplinary collaboration. GCMR serves as a vital platform where academics, industry experts, and students from diverse fields can come together, share their insights, and ignite conversations that lead to real-world solutions. This year's conference features a rich array of research across sectors, aiming to inspire action and innovation.

I extend my heartfelt appreciation to the organizing committee, editorial teams, reviewers, and volunteers whose dedication and hard work have made GCMR 2025 possible. I am also deeply grateful to authors, sponsors, and all supporters who have contributed in making this event a success.

To all participants, I encourage you to engage deeply, exchange ideas, and form meaningful connections during your time here. I am confident that GCMR 2025 will be a truly enriching experience for all, fostering new ideas and collaborations that will help shape a better tomorrow.

Wishing you all a successful and inspiring conference.

Message from the Conference Co-Chair

Dr. Kasun Karunanayaka

University of Colombo, Sri Lanka

It is with great pleasure that we welcome you to the Global Conference for Multidisciplinary Research (GCMR), organized by Achievers International Campus, Sri Lanka. This conference represents a significant milestone in our ongoing commitment to fostering innovation and collaboration across various fields of study.

We extend our heartfelt gratitude to the dedicated staff members of Achievers International Campus and the conference organizing committees. Their immense contributions and tireless efforts have been instrumental in making this event a reality. Without their hard work and dedication, this conference would not have been possible.

We would like to congratulate all authors whose papers have been accepted for presentation at the conference. Your research and insights are the cornerstone of this event, and we are excited to see the diverse range of topics and ideas that will be discussed.

We hope that the experience gained through this conference will inspire you to present your research at future conferences, both within Sri Lanka and on international platforms. The knowledge shared here today has the potential to drive further advancements in the domain of ICT and beyond. Let's work together to make each conference a pleasant and memorable experience, filled with valuable exchanges and lasting connections.

As we conclude, we hope that you have not only shared your knowledge but also taken back insights that will further your research endeavors. Remember, your network is more valuable than your net worth. Building strong connections and collaborations is key to advancing your work and achieving success.

Thank you for being a part of this conference. Looking ahead, we would like to extend an invitation to all participants to join us for the next GCMR conference, which will take place next year.

Warm regards,

Dr. Kasun Karunanayaka
Conference Co-Chair
Global Conference for Multidisciplinary Research (GCMR 2025)
Achievers International Campus, Sri Lanka

Message from the Conference Co-Chair

Ms. Amandi Kulasinghe

Achievers International Campus, Sri Lanka

"The best way to predict the future is to create it." Peter Drucker

It gives me immense pleasure to welcome all participants, researchers, and guests to the Global Conference for Multidisciplinary Research (GCMR) 2025, hosted by Achievers International Campus, Sri Lanka.

This year's theme, "Leveraging Emerging Technologies for Sustainable Development in the Global South," speaks directly to the transformative power of research and collaboration in shaping a better future. As we navigate a world of rapid change and innovation, forums like GCMR provide a crucial platform for exchanging ideas, challenging perspectives, and building lasting partnerships across disciplines.

I wish to express my deepest gratitude to the organizing committee, reviewers, staff, and volunteers who have worked tirelessly to bring this event to life. Their commitment ensures that GCMR continues to grow as a space for academic excellence and meaningful dialogue.

To all presenters, congratulations on having your work selected. Your dedication to advancing knowledge is what fuels the spirit of this conference. I encourage you to engage deeply, ask bold questions, share generously, and be open to new collaborations that can extend beyond this event.

I hope that the GCMR 2025 not only enriches your academic journey, but also inspires you to carry forward the connections and ideas sparked here. Together, let us harness the power of innovation for a more sustainable, inclusive world.

Thank you for being a part of this important gathering. I look forward to seeing you again at future editions of GCMR.

Wishing you all a rewarding and inspiring conference!

Ms. Amandi Kulasinghe
Conference Co-Chair, GCMR 2025
Achievers International Campus

Message from the Co secretary

Mr. Thomas Benjamin Jeganathan

Chief Academic Officer, Achievers International Campus

It is my honour to share this message to be incorporated in the sessional proceedings published by Achievers International Campus, Colombo in connection with the 9th Edition of the Global Conference for Multidisciplinary Research (GCMR) 2025.

The primary objectives of GCMR 2025 are to promote scholarly exchange and interdisciplinary collaboration, while harnessing emerging knowledge and innovative practices for a sustainable and prosperous future. The conference aims to spark dialogue on the transformative potential of technology in enhancing quality of life—particularly in developing countries—and to build a shared understanding of the challenges and opportunities in applying emerging technologies for sustainable development. Furthermore, it seeks to provide a dynamic platform where scholars from diverse disciplines can engage around common issues, fostering convergence of ideas and solutions.

Scheduled for the 3rd of April 2025, this prestigious event welcomes the participation of both local and international academics, emerging and renowned scholars, distinguished researchers, industry experts, policymakers, students and thought leaders to present their work and interact meaningfully and engage in insightful discussions that contribute in shaping the trajectory of global development. Their contributions will collectively advance knowledge across a wide range of disciplines and serve as powerful catalysts for both scientific progress and societal impact.

This year, the conference will focus on key domains including Business Management, Information Technology, Engineering, Law, Strategic Management & Leadership, Education, Innovation, and Sustainability.

I am confident that GCMR 2025 will provide an enriching space to address pressing global challenges, share innovative ideas, and explore transformative solutions.

Research and development are the bedrock of new knowledge. This conference offers an open and inclusive forum for participants to exchange perspectives and deepen their understanding through constructive dialogue.

Looking ahead, I hope the faculty continues to gain wisdom, enthusiasm, and expertise from this vibrant academic ecosystem, further strengthening its contributions to society in the fields of Humanities and Sciences.

I extend my appreciation to the Organizing Committee, Heads of Faculties, Programme Managers, the Academic and Non-academic staff of Achievers International Campus for their dedication in bringing this event to fruition.

I wish all participants a highly productive and rewarding conference experience.

Thomas Benjamin Jeganathan Chief Academic Officer
Achievers International Campus

Message from the Co secretary

Mr. Charinda Sumanasekara

Head of Academic Operations, Achievers International Campus

It is with great enthusiasm and deep appreciation that I extend a warm welcome to all participants, presenters, and delegates joining us for the Global Conference for Multidisciplinary Research (GCMR) 2025, proudly hosted by Achievers International Campus.

The idea for this conference began as a modest seed—an inspired conversation among a small group of passionate academics who envisioned a platform to bring together diverse disciplines under one roof. With the unwavering support and strategic guidance of our management, that seed has grown into a thriving tree—GCMR 2025—standing tall as a hub for intellectual exchange and global collaboration.

The theme of this year's conference, "Leveraging Emerging Technologies for Sustainable Development in the Global South," reflects our commitment to aligning academic discourse with real-world challenges and solutions. The Global South is on the cusp of profound transformation, and academic platforms like GCMR are instrumental in fostering the innovation, inquiry, and partnerships necessary to catalyze that change.

At Achievers International Campus, we are dedicated to academic excellence and operational integrity. As the Head of Academic Operations, I take great pride in the systems and standards that have guided the rigorous review, selection, and presentation processes of this year's research submissions.

"Education is the most powerful weapon which you can use to change the world." – Nelson Mandela

Each abstract and paper featured at GCMR 2025 has undergone a meticulous academic review process—thanks to the unwavering efforts of our editorial and technical teams.

I would like to express my sincere gratitude to the organizing committee, session chairs, reviewers, volunteers, and academic contributors who turned this vision into reality. Your dedication has not only upheld academic quality but also cultivated an inclusive and inspiring environment for learning, sharing, and innovation.

To all researchers—both established and emerging—I encourage you to fully engage in the sessions, build meaningful connections, and boldly explore how your work can contribute to a more sustainable and equitable world.

Wishing you an insightful, energizing, and impactful conference experience. May GCMR 2025 be a launchpad for new ideas, lasting partnerships, and transformative research.

Mr. Charinda Sumanasekara
Co-Secretary & Head of Academic Operations
GCMR 2025 – Achievers International Campus

Co Chair

Ms. Amandi Kulasinghe
Managing Director
Achievers International Campus

Dr. Kasun Karunanayaka
Head of School of Computing
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Mr. Benjamin Jeganathan

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Special Thanks

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INFORMATION TECHNOLOGY

Enhancing Web Programming Learning: Real-Time AI Assistance on Student Engagement and Feedback Timeliness with WEB-GURU

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Keywords

Dementia, Cognitive Rehabilitation, Accessibility, Computational Models, Human-centered AI

Over the past few years, there has been a significant transition in programming education from traditional methods to virtual and online methods. Students' adaptability was greatly increased by this, but it also brought about new difficulties. The study conducted by (Pregowska et al., 2021) asserts that although distance learning has benefits, it also has drawbacks, including less social connection and a lack of experiential learning (Greenhow et al., 2022). Immediate guidance and interaction during practical sessions, which are crucial in enabling students to understand some hard programming concepts, have likely been the biggest barrier in such a move. When students confront challenging problems or concepts that need hands-on explanation, the restricted opportunity for real-time help and the ensuing delay of response might impede learning results and can leave them feeling alone. The students feel a lot of loneliness, particularly when they switch from in-person to online instruction, according to a study by (Kee, 2021). Some students stated that being unable to physically engage with peers and educators made them feel even more alone.

Artificial intelligence (AI) is revolutionizing education by effectively managing large amounts of data and tailoring instruction, particularly in online environments where conventional approaches might not be sufficient. Numerous studies on AI's application in education have been conducted, emphasizing the advantages it offers to educators as well as students. Numerous applications of AI technology, including chatbots, expert systems, intelligent tutors, machine learning, personalized learning systems, and visualizations, are being incorporated into the educational process (Zhang & Aslan, 2021). The research conducted by the (Fitria, 2021) examines how AI is used in education, particularly in the process of teaching and learning. Further, the study shows the various educational technology platforms such as virtual mentors, voice assistants, smart content, automatic assessment, personalized learning, and Intelligent Tutoring Systems (ITS). The authors of (Hasan et al., 2023) explain how the Input Process Output (IPO) analysis approach was used to build and implement an AI chatbot that has good student perceptions and the potential to enhance programming skills as a personal learning assistant for programming coursework. AI chatbots are being used in Indian higher education to enhance student learning, with a focus on the benefits and challenges of integrating this technology into the classroom (Sandu & Gide, 2019). The potential of chatbots to help students with their academic challenges, students' willingness to utilize chatbots for learning, and the absence of a clear correlation between chatbot adoption and gender, age, or educational achievement are some of the study's main findings. Natural Language Processing (NLP)-capable AI systems, may analyze student code in programming classes, identify errors, and provide immediate corrections. The study

by (Piech et al., 2013) found that AI-driven feedback improved students' performance in programming classes and increased their confidence in coding. This automated feedback system helps educators by ensuring that pupils receive the assistance they need more quickly. According to research by (Anderson et al., 1995) cognitive tutors and AI-powered resources that assist students in real-time problem-solving are beneficial. These systems have been shown to enhance learning outcomes by adapting to the student's pace, giving feedback on errors, and pointing students in the direction of the correct answers. The ITS in programming that is widely used is the Python Tutor (Shute et al., 2015), which allows users to watch their code run in real-time. With the use of this application, students can better visualize abstract concepts by comprehending the data and control flow in their applications. According to research, using these visualization tools helps students

better understand programming concepts and reduces the mental stress associated with troubleshooting. The literature review emphasizes the revolutionary significance of AI in education, emphasizing how it may improve teaching methods, increase learning results, and offer educators and students individualized support.

Traditional teaching techniques have changed in recent years due to the rapid growth and development of educational technologies, especially in the area of web programming. Because of the inherent complexity of web programming languages like HTML, CSS, and JavaScript, it can be difficult to provide immediate feedback and hands-on instruction in traditional classroom settings or static online courses. In order to overcome these difficulties, this paper presents WEB-GURU, an AI-powered learning platform that incorporates real-time AI support into virtual web programming modules. WEB-GURU is designed to improve overall learning results, decrease feedback delays, and increase student engagement and interactive elements. AI integration into educational platforms becomes a really promising approach in this regard. Personal tutoring, task automation, and instant feedback are all possible with AI in other words, it's an interactive adaptive learning environment. The development of WEB-GURU will involve bridging the gap between cutting-edge educational technology resources and current traditional teaching approaches. Accordingly, this platform addresses the specific needs of students in a rapidly growing field while leveraging AI to enhance their learning experience.

WEB-GURU is designed as a comprehensive platform for web programming practical sessions. It has unique features for educators and students, such as an AI-powered assistant, a code editor with live preview, and an intuitive dashboard. A coding editor with a live preview, an AI-powered assistant to complete practical tasks, and a chatbot for additional assistance are all made possible by the student dashboard. Figure 1 shows the student dashboard. The code editor provides a real coding environment, equipped with syntax highlighting and auto-suggestions for HTML tags. A live preview feature that allows students to see the output of their code instantly, enabling them to test and refine their work in real-time. Students can access a series of practical tasks uploaded by their educators. Figure 2 displays a practical task and the student's answer. Each task includes a dedicated code editor and live preview, allowing students to work on and test their solutions seamlessly. The structured organization of tasks ensures a clear progression in learning. The AI assistant is a core feature of WEB-GURU. It provides personalized guidance based on the task requirements and the student's current progress in the code editor. Students can overcome coding problems and learn best practices with the help of the recommendations provided by the WEB-GURU AI assistance. WEB-GURU chat is accessible for the students and the chat allows students to ask questions related to coding tasks or general programming concepts.

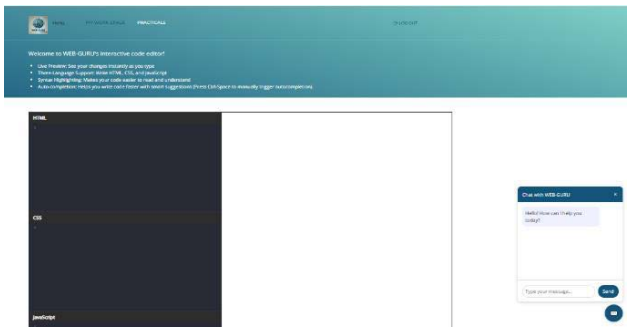

Figure 1: code editor with live preview in student dashboard

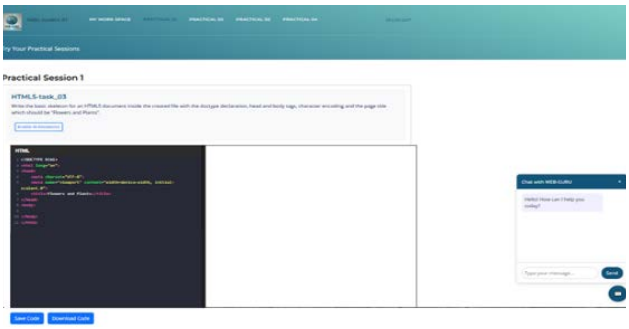

Figure 2: An AI-assisted practical task environment

Depending on the practical number, the instructor dashboard provides a window for uploading the various practical activities. Figure 3 shows the instructor dashboard. Instructors have access to both the student's submitted code and a live preview of it (figure 4). The WEB-GURU platform demonstrates the transformative potential of AI in web programming education. The revolutionary potential of AI in online programming instruction is exemplified by the WEB-GURU platform. It addresses the drawbacks of conventional approaches and offers a dynamic, interactive, and student-centered educational experience. Real-time feedback and AI support greatly improve engagement and reduce delays, opening up the path to more efficient programming instruction. WEB-GURU seeks to establish a new benchmark for online learning environments by means of constant innovation and improvement, enabling both educators and learners to succeed in the constantly changing realm of web programming.

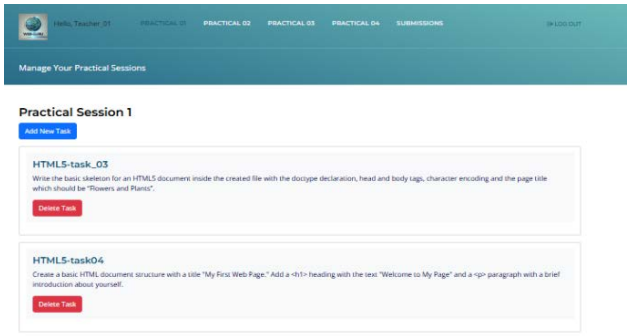

Figure 3: Dashboard for instructors to upload practical tasks

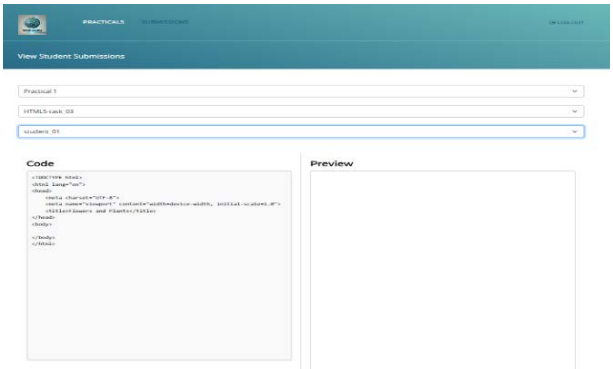

Figure 4:Submitted codes in instructor view with a live preview

The WEB-GURU platform demonstrates the transformative potential of AI in web programming education. This study addresses the limitations of traditional approaches and offers a dynamic, interactive, and student-centered learning experience. Real-time feedback and AI support enhance engagement and reduce delays, opening the door to more efficient programming learning.

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Voice-integrated Augmented Reality for Cognitive Rehabilitation in Dementia Patients

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Keywords

Dementia, Cognitive Rehabilitation, Accessibility, Computational Models, Human-centered AI

Dementia is a neurodegenerative condition common among the elderly community, which shows a significant decline in cognitive abilities, such as memory recall and problem-solving skills. It is a progressive disease that spans several stages, from no cognitive impairment to very severe cognitive decline, including very mild cognitive decline, mild cognitive decline, moderate cognitive decline, and moderately severe cognitive decline [1]. Currently, over 55 million people are living with dementia worldwide, and the direct cause of dementia is undiscovered [2]. The number of people living with dementia is expected to triple, from 50 million in 2018 to 152 million by 2050 [3]. The decline in cognitive abilities varies from person to person, depending on the stage of the condition. Providing better care and improving the quality of life for these patients is crucial, as dementia affects millions globally. Additionally, by 2050, there is expected to be a significant gap between diagnosis rates and resource availability for managing the neuropsychiatric symptoms of dementia in low-income countries compared to high-income countries [4].

Despite advancements in visual augmentations, accessibility issues remain, as many solutions adopt a one-size-fits-all approach without considering individual needs. Common deficits among dementia include cognitive decline, short and long-term memory loss, disorientation in time and place, sensory and attention deficits, judgment difficulties, and challenges in processing spatial and visual data [5]. Research on assistive technologies for people with dementia focuses mainly on enhancing, detecting and monitoring impairments related to the dementia condition. Among these, the most impact is on the decline in cognitive abilities which directly impacts quality of life and independence.

Augmented Reality (AR) applications integrate digital elements into the physical environment through easily accessible devices, such as smartphones [6]. AR has demonstrated its ability to provide interactive and user-friendly experiences, as it does not pose physical challenges like motion sickness, which is common in Virtual Reality applications. Key AR-based research to enhance cognitive abilities in people with dementia includes cognitive stimulation [7] and memory games [8] etc. Regarding games implemented, [12] noted that the combination of serious games and gamification elements promotes continuous engagement by stimulating the user's desire to participate.

Although research explores incorporating AR into dementia care, challenges remain. Studies suggest that people with dementia understand information better when conveyed through a human voice rather than as statistical data [9]. Additionally, older adults prefer voice interactions over touchscreen buttons [3], and using voice

commands instead of image cues can extend battery life [10]. However, due to the severity of dementia, AR device usage can fluctuate, even when applications include auditory cues. Users may require step-by-step support based on their cognitive condition [11]. Furthermore, [12] found that, despite the created gaming applications being designed to measure cognition, most people with dementia tend to seek help during gaming activities, as they are uncomfortable trying new things independently. This highlights the need for an adaptive computational model that combines voice-based interactions and AR-based cognitive tasks, allowing real-time adjustments according to cognitive level estimations.

Given the positive impact of voice on cognitive load and AR-related applications, this ongoing study develops an AI-driven adaptive framework for a voice-integrated AR application that provides personalized cognitive training for people with dementia. The application is tailored to each individual's disease stage and demographic factors such as age and gender. Initially, the study identifies key training activities for different cognitive clusters and investigates how to detect real-time fluctuations in users' cognitive states. To achieve this, the study first focuses on identifying users' current cognitive states based on their disease stage and cognitive abilities. Researchers then explore how to integrate AR gaming components to assess cognitive variations in individuals with dementia. Additionally, the study identifies the most effective graphical activity components and audio commands to be incorporated into the AR application to enhance cognitive function, and to achieve the objective of developing a voice-integrated AR application tailored to users' cognitive abilities and dementia stages.

This research is conducted through a combination of domain literature reviews, qualitative interviews with people with dementia and their caregivers, and user-centric design workshops. The graphical elements and audio cues developed will be implemented as interactive gaming tasks in a mobile-based AR application, with structured levels designed to enhance and monitor cognitive function.

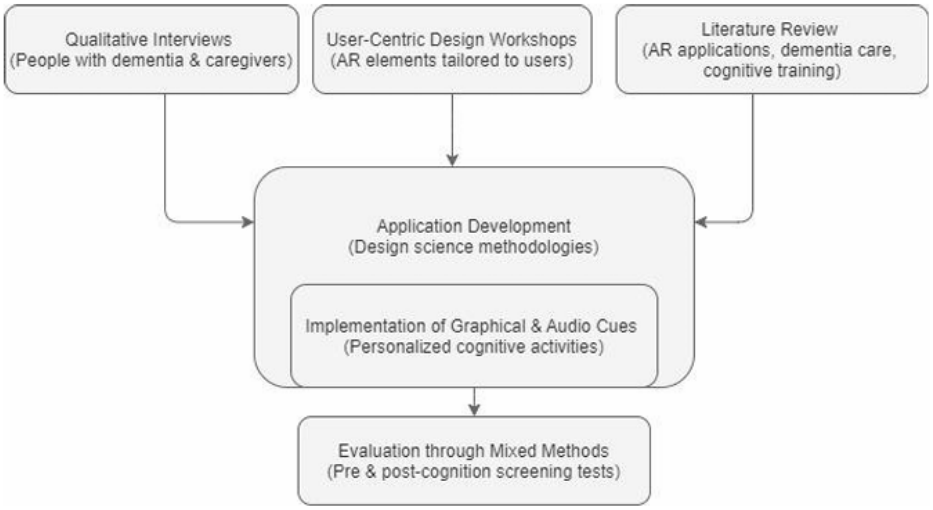

Figure 01: high-level diagram of the research study

The application will be developed using design science methodologies and evaluated through mixed methods. Changes in cognitive levels will be assessed using pre and post-cognition screening tests, employing cognitive assessment tools on a sample of people with dementia at varying disease stages. Additionally, engagement levels will be measured through usage data, interaction frequency, and qualitative caregiver feedback. The outcomes of this research will include identifying effective cognition-enhancing graphical components for different dementia clusters, determining users'

cognitive states in real-time, and developing an adaptive learning algorithm to suggest appropriate gaming components based on users' cognitive abilities. This study aims not only to enhance cognitive function in people with dementia through voice-integrated simulation technologies, but also to advance personalized, accessible, and effective AR-based cognitive training solutions.

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Hybrid Machine Learning-Driven Cyberattack Prevention for Suspicious IP Reputation Validation in Geographically Isolated VPN-Tunneled IoT Networks

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Abstract

The research discusses a dual machine learning framework for cyber defense operations which validates uncertain IP addresses through VPN-based VPN tunnels in autonomous IoT systems. The static blacklist method for reputation systems faces limitations when dealing with new cyber threats within IoT networks that have restricted resources. The solution creates a hybrid supervised learning framework which unites Deep Learning algorithms with Random Forest functionality to monitor IP reputations through current threat intelligence and geographic detection as well as activity monitoring. Federated learning enables our security solution to protect privacy by integrating into the system to improve security functions. The security framework for IoT networks exhibits robust features because it achieves both 98% detection accuracy and significant improvement in false positive reduction.

Introduction

Remote IoT networks which serve agricultural operations and manage industrial automation as well as environmental observation systems deal with specific cybersecurity threats [1]. Threat detection and important updates become challenging on networks that work with restricted connectivity. Network protection systems based on traditional IP reputation techniques use fixed blacklists that do not work with rapidly emerging cyber dangers according to research [2]. Security enforcement becomes complicated because of both dynamic IP address systems and heterogeneous devices in networks [3]. A hybrid machine learning-based solution [11] presents itself as an answer to better IP reputation validation by implementing adaptive learning techniques with real-time threat mitigation abilities [4].

Related Work

Traditional systems that evaluate IP reputation use security log blacklists combined with open-source intelligence. The reputation systems deliver successful results in settled systems, yet they lack effectiveness in changing IoT systems. Research studies have examined anomaly-based intrusion detection systems (IDS) mentioned in [6] although these systems generate numerous false positives according to [10]. The proposed reputation-based trust management frameworks show promise by developing adaptability although they fail to achieve it [7]. Complete IP reputation evaluation through machine learning applications in our combination model produces enhanced precision while being adaptable in multi-center IoT networks [8].

Methodology

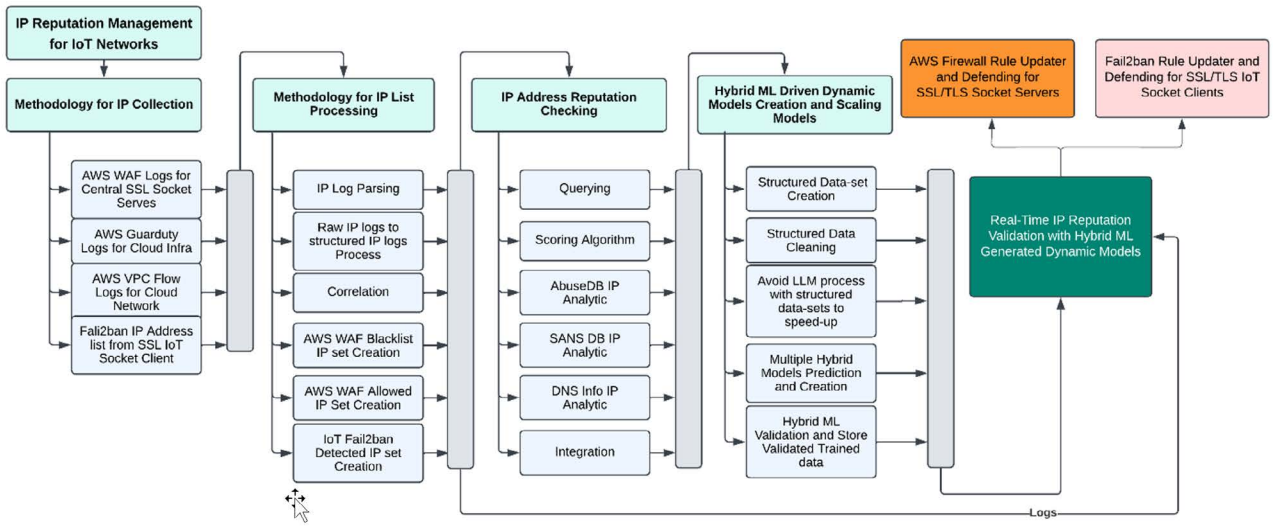

Figure 1: Methodology for Hybrid-ML Driven IPR Validation

Data Collection and Preprocessing

Figure 1 shows that the information retrieval process combines IP addresses and traffic patterns taken from several platforms which include AWS WAF logs along with GuardDuty and public threat intelligence databases such as AbuseDB and SANS. A log processing pipeline analyses, cleans and organizes information to gather essential fields comprising timestamp, source IP address and destination IP address and activity type.

Machine Learning Model

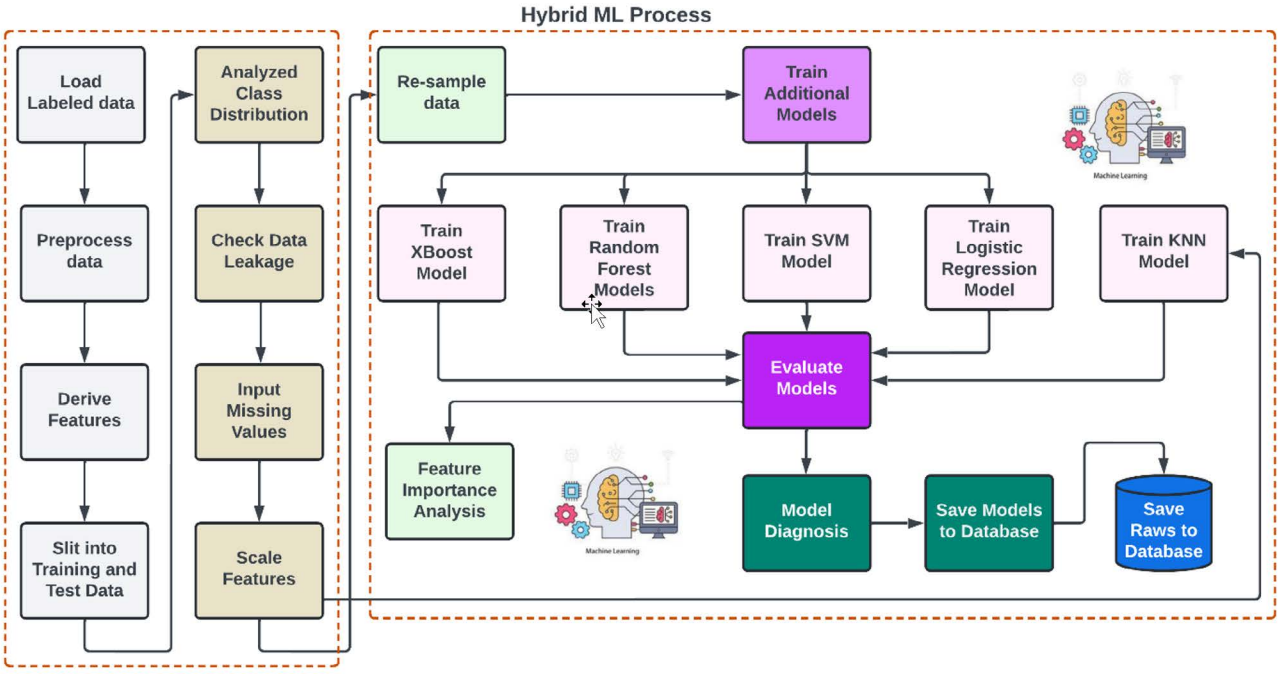

Figure 2: Hybrid-ML Models Creation for IPR.

Figure 2 shows that the Hybrid model combines:

- Random Forest (RF) for feature selection and initial classification.
- Deep Learning (DL) for behavioral pattern recognition and adaptive learning.

The system utilizes Federated Learning as a method to protect privacy while it optimizes model training through keeping raw data confidential.

Real-Time Triple IPR Validation ML-Driven Architecture

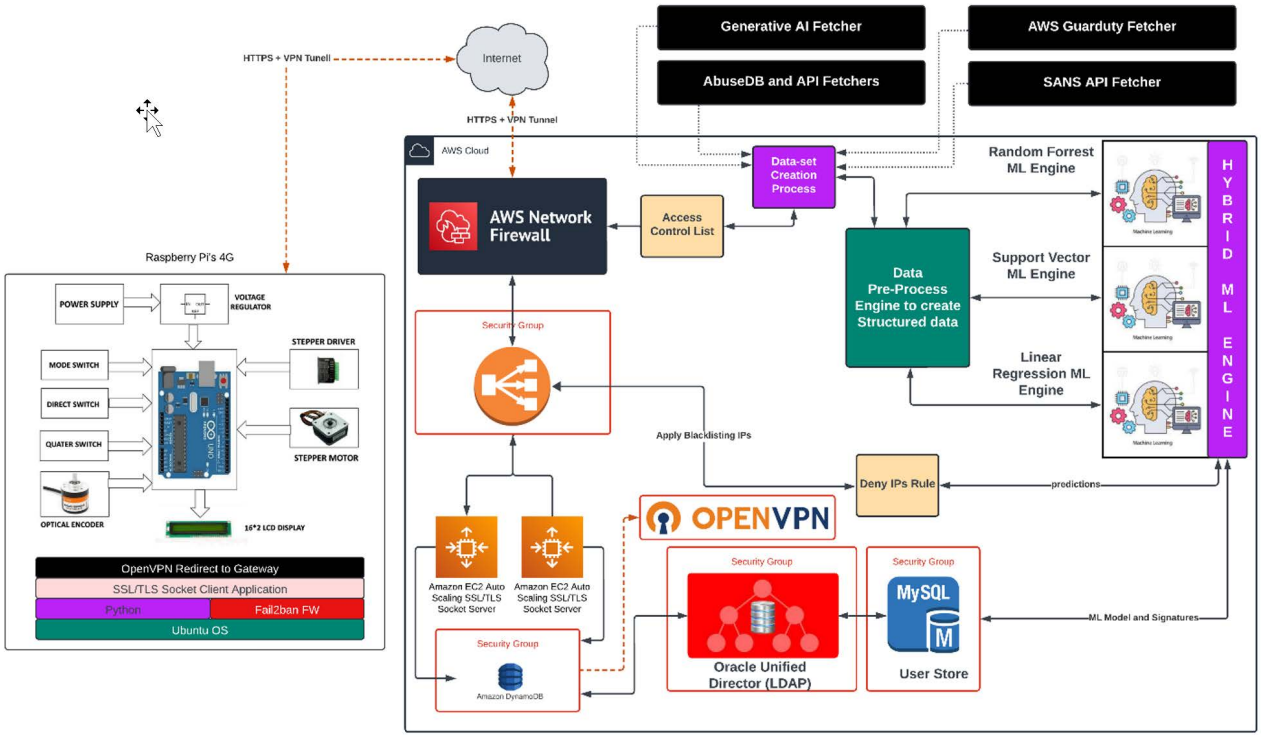

Figure 3: Experimental Setup

Figure 3 shows that the Realtime scoring algorithm runs continuously to verify IP reputation values. The system blocks high-risk IPs instantly while it validates low-risk IPs for possible suspicious actions.

Firewall and Security Automation

The system ensures IoT network protection from developing threats by implementing automatic AWS firewall rule updates together with Fail2ban configuration revisions.

Results and Discussion

Performance Metrics

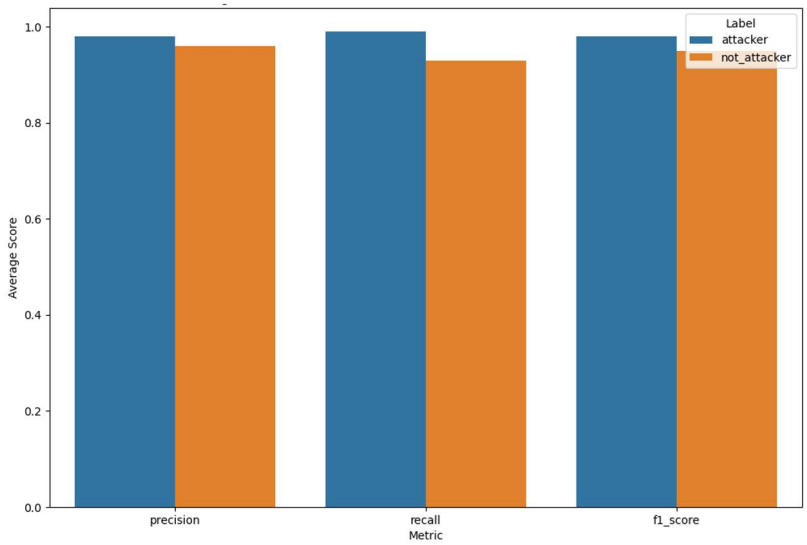

Figure 4: Overall ML Predictions.

Figure 4 shows that the evaluation of the model took place using a list containing established malicious and benign IP addresses. The following metrics were used:

- Precision: 98%
- Recall: 92%
- Positive False Rate: 0.5%
- Accuracy: 98%

Comparative Analysis

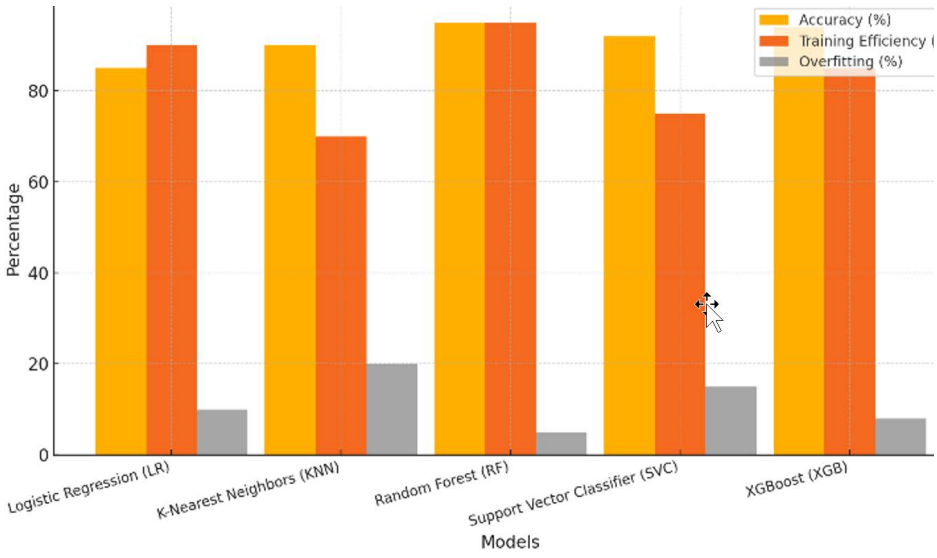

Figure 5: Hybrid Models prediction comparison.

Figure 5 shows that the hybrid detection system provides better performance than conventional blacklist systems through an improvement of both threat identification and a 90% reduction in false alarms. A federated learning system allows for constant improvements through its framework which protects privacy because it does not exchange data directly.

Comparative Analysis

The research presents a brand-new combination of machine learning techniques that performs IP reputation examination within disconnected IoT networks. The security implementation through this model accomplishes several purposes by providing automated threat response along with reduced false notification detection while using federated learning to protect user privacy. Real-time threat analysis combined with privacy-aware collaboration functions through this solution to properly deal with security challenges in distributed systems.

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Sinhala Sign Language Translation: A Hybrid Approach with Machine Learning and Sign Synthesis

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All human beings need equal opportunities in the world. Communication is one of the essential things for humans to do in their day-to-day activities like learning, expressing their feelings, and exchanging their ideas. However, over 5% of the world's population, or 430 million individuals, including 34 million children, require healing to manage disabling hearing loss. Commonly referred to as being deaf. (WHO, 2024). They often find it challenging to share their thoughts with hearing people through spoken language. So, they rely on unique forms of communication, including hand gestures and facial expressions known as sign language. These are typically learned in specialized schools for the deaf (Alaghband et al., 2023). There are around 300,000 Sinhala-speaking deaf and hard-of-hearing persons in Sri Lanka use Sinhala sign language for their communication. Unfortunately, hearing individuals do not have access to those schools, leading to a communication gap between deaf and hearing communities and limiting the exchange of expressions and ideas (Udugama et al., 2024)

To overcome this gap, an automated communication system is needed that does not rely on human interpreters. There are so many systems that have been developed in the last decades for hearing people to share their expressions with deaf individuals. Simultaneously, some translation systems have been developed for Sinhala sign language using different translation methods. These systems leverage Natural Language Processing (NLP), Machine Translation (MT), and Computer Vision (CV) to convert text into sign language representations. However, those current text-to-sign language translation systems face some challenges related to translation accuracy, linguistic complexity, lack of datasets, sign language diversity, and avatar realism. We propose a web-based Sinhala Sign Language translation system where users can input Sinhala text and receive accurate sign language translations through animated avatars, eliminating the need for specialized hardware or software installations. We aim to develop a more accurate, and naturalistic text-to-sign language conversion system capable of handling complex sentence structures, supporting multiple sign languages, and producing highly expressive sign animations.

Through the literature review, we have identified key limitations and research gaps in existing sign language translation technologies globally which can be categorized based on machine translation methods and sign synthesis. Many systems use rule-based machine translation methods for doing the text-to-sign conversion. A rule-based translation system is one of the machine translation methods that is based on linguistic information about the source and target language. Rule-based systems take sentences of the source language as input and then generate them to output sentences based on syntactic, semantic, and morphological analysis of both source and target languages. (Kahlon & Singh, 2023). In many earlier works, the role of grammar development has been essential. A few years ago ATLASLang MTS1 system

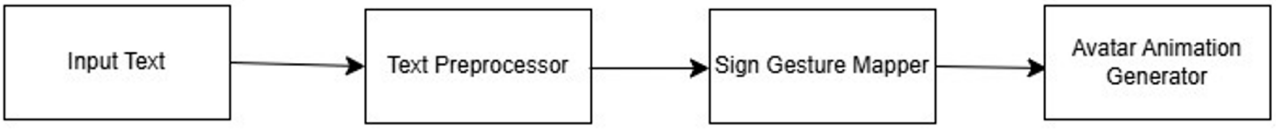

Figure 1: Highlevel Architecture of proposed solution

converted Arabic text to Arabic sign language (Brour & Benabbou, 2019), while another system facilitated English text to Indian Sign Language translator,(Gupta et al., n.d.), and also in 2018 the desktop application that was used to covert Pakistan sign language translator (Wasim et al., 2018), and some other systems also adopted a similar approach for translation. Based on those applications, certain limitations have been observed. The present research mainly deals with the conversion of simple sentences and words to sign language, reducing accuracy in complex sentences that deaf individuals use in everyday conversions. Additionally, unlike British and American sign languages which have established grammar rules and formal definitions, Sinhala sign language lacks the necessary foundational structures for an effective rule-based system (Udugama et al., 2024). Therefore, a robust language model and extensive sign language rules analysis can be a potential research area in the future. In contrast to rule-based approaches, the corpus-based machine translation model works on examples, statistical decision theories, and learnings, which do not require grammar rules and dictionaries. Although a large corpus is essential for data-driven systems, few datasets have been created in previous years. Hence, it should be focused on creating large datasets for all sign languages. Apart from that, most of the studies of sign language machine translation present a single language translation system (Alaghband et al., 2023). More effort can be made to bridge the communication gap between different deaf communities through multilingual datasets like DICTA_SIGN (Efthimiou et al., 2009)and MultiATIS++ (Xu et al., 2020) corpus.

Neural machine translation is a highly utilized concept in various technological developments. It employs methods of deep learning, neural networks, attention mechanisms, or transformer models, allowing the system to recognize certain types of words and sentences. Unlike rule-based and corpus-based methods, NMT can process complex sentence structures, and generate more accurate translations. Previous results have demonstrated that NMT outperforms traditional methods, often leading to groundbreaking results. So, it is possible to significantly improve the quality and naturalness of sign language representations by integrating deep learning models.

In addition, in the sign synthesis phase, the animation of generated sign language sequences is another essential part of text-to-sign translation. Identified sign synthesis studies reveal that avatar animation is the most suitable sign production among all kinds of sign synthesis. TESSSA which is used as to motion capture method to directly capture human signer movements and coupled this with virtual human Suse da Simon-the-signer 3D model for animation (Van Zijl & Olivrin, 2008). Other projects have also employed these animation technologies to visualize sign gestures, (Thrimahavithana et al., 2019) (Elliott et al., 2008) (Punchimudiyanse & Meegama, 2017), but those systems have drawbacks; those animations may not be user-friendly, or sometimes feel more artificial, and will be unfamiliar to deaf communities. Additionally, those systems failed to accurately represent non-manual features, such as facial expressions, movements of eyes, mouth, and eyebrows. So this should be focused on temporal coordination between manual and non-manual components for signing to appear natural. (Alaghband et al., 2023). A Sinhala sign language used by the Sri Lankan deaf community faces similar challenges, including insufficient data sets and a lack of well-defined linguistic rules.

Although Sinhala sign language shares certain similarities with British Sign Language, many of its rules differ, making it difficult for direct translation. The primary motivation for this research is the scarcity of data sets and the limited linguistic research available on Sinhala sign language translation (Groundviews, 2021)

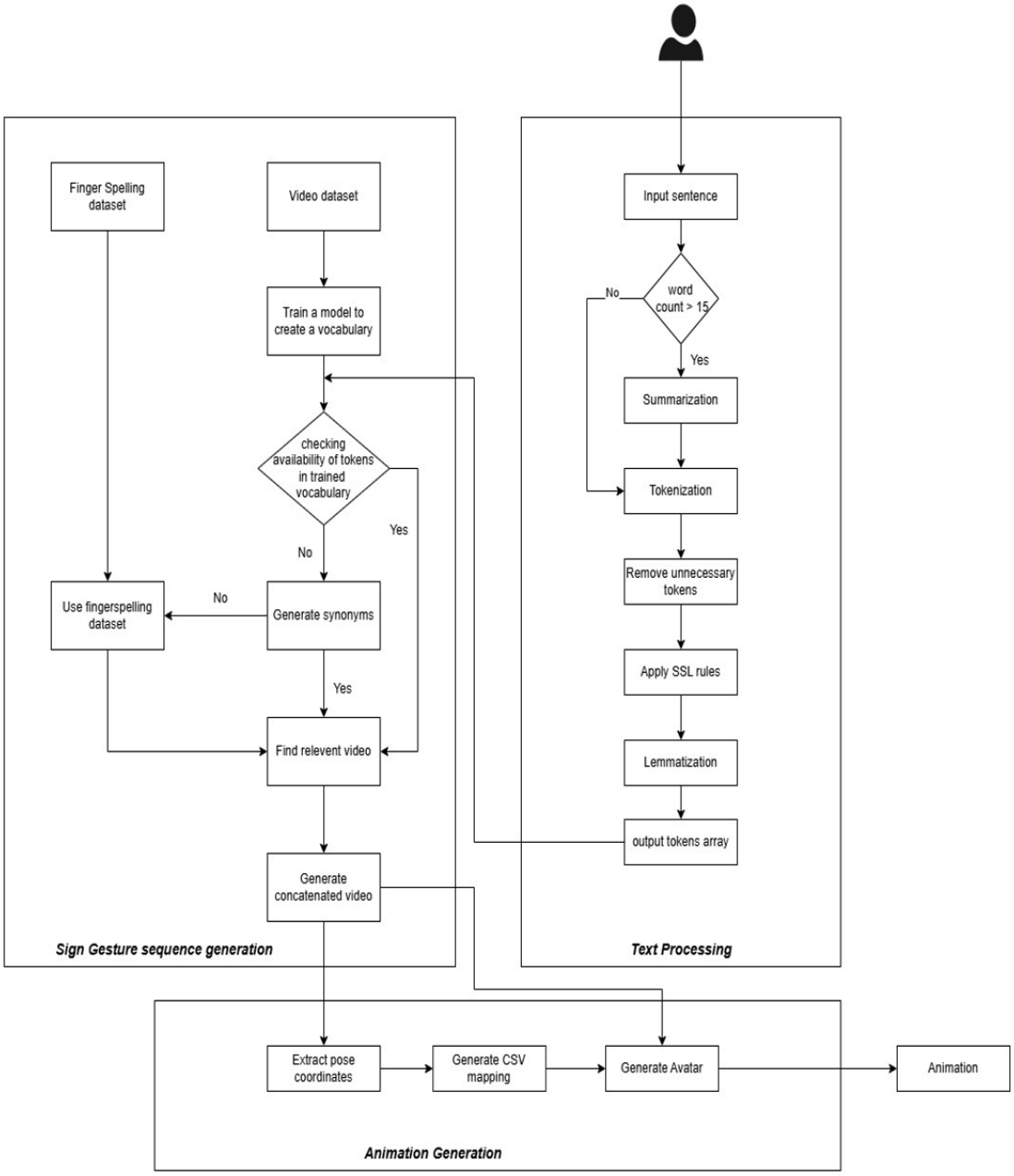

Figure 2:Detailed system Architecture of the proposed web application

To overcome these challenges, the proposed system aims to contribute to the field of automated sign language processing by the following steps. Our proposed web application consists of three main parts that is displayed in Figure 1. The first part is text preprocessing, which begins by checking the input text size. If the text is too long, summarization techniques are applied to extract the semantic meaning to ensure more accurate outputs. After summarization, semantic rules are used for stemming, and lemmatization is applied to obtain the base form of words. Once the tokenization part is completed, the tokenized word array is sent for the next step. This process ensures

accurate mapping of spoken sentences with Sinhala sign language gestures without causing any mismatches. Currently, our system takes input as an English text, but we are also further developing it to support Sinhala langauge.

The second step is to create a sequence of sign gestures using machine learning concepts and video generation concepts. Our training pipeline involves a deep learning-based approach for video category prediction on the structured data set in Kaggle. Pre-processing includes mapping categories to their corresponding numerical indices. A fully connected neural network that is coupled with an embedding layer predicts the categories using a multi-class classification approach. Cross-entropy loss was employed for category classification and optimized using the Adam optimizer. The model will undergo training for many epochs using back propagation and batch processing to guarantee convergence. We then save our model and vocabulary mappings for later inference after training. Using this model, we predict the word indices for each tokenized word. If a word is not found in the vocabulary, we generate synonyms and map them to the vocabulary. If a word is still unavailable after this process, we use fingerspelling to represent it letter by letter. This applies to words that are not in the vocabulary, such as names, village names, and proper nouns. After mapping, we generate a concatenated video representing the input sentence and then send it to next step. The third step involves animation generation. Using the concatenated video, we extract pose coordinates from the video using Open CV libraries including facial expressions, these coordinates are then mapped to a rigged skeleton model (Mixamo, n.d.) to animate sign gestures creating user-friendly avatar. The general architecture of the system is shown in Figure 2.

For future results, we are planning to extend this system to support multiple sign languages, allowing cross-inguistic communication among diverse deaf communities. Additionally, we are planning to create a sign Language video dataset for word and phrases categories for both English and Sinhala spoken Languages and improve realism of sign language animations.

The anticipated results of this research include the creation of a scalable Sinhala Sign Language translation system that significantly enhances communication between deaf individuals and hearing individuals. By solving existing limitations in sign language translation, we aim to pave the way for future advancements in this field. This research contributes to the broader field of sign language processing by providing a hybrid approach to Sinhala Sign Language translation.
Using state-of-the-art machine translation techniques and sign synthesis methods, this study creates a foundation for future developments in automated sign language translation systems.

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Navigating Privacy and Ethical Challenges in the Age of Artificial Intelligence

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Abstract

Artificial Intelligence (AI) is changing industries, enhancing efficiency, and altering life in general. Nevertheless, its speedy development raises profound concerns regarding ethics and privacy. AI's ability to collect, analyze, and utilize enormous amounts of individual information poses danger, and a delicate balancing act between technological development and safeguarding individual liberties is necessitated AI naturally requires enormous amounts of information in order to function effectively, and in many instances, in a manner not explicitly agreed to by its users; incredibly sensitive individual information is harvested, and profound concerns regarding security vulnerabilities, unauthorized observation, and misuse through companies and governments develop. Facial recognition technology has been particularly contentious in that it was utilized for bulk observation and actually posed a direct challenge to individual liberty. AI-powered personalized advertisement oftentimes exploits user information and blurs a thin boundary between ease and intrusion. Most AI programs lack transparency in working with information; a user does not have an idea about how his/her information is stored and shared. With little in terms of legislation regarding data protection and ethics, AI enriches society at an expense of individual anonymity. AI brings tremendous breakthroughs, but with them, raises profound ethical concerns. Bias is one such issue—AI programs replicate biases in training sets, creating unjust consequences in such sectors as work and policing. Transparency is an issue, too: many AI programs function in a "black box", and it is effectively impossible to understand how and why an AI reaches a conclusion. That raises accountability concerns, particularly when AI touches lives. AI-created disinformation and deepfakes make it increasingly challenging to discern fact and fiction. To develop ethical AI, builders must make technology fair, transparent, and accountable, and not permit technology to amplify bias and disperse disinformation. To tackle AI's ethics and concerns regarding privacy, governments, technology companies, and citizens must collaborate in a united effort. Stringent legislation such as GDPR can protect information about users, but companies must act responsibly and make AI systems transparent and fair. Developers must actively work to counteract bias through use of a range of datasets and continuous audits of algorithms. AI models must be transparent and understandable, with users knowing both how and why a decision is reached. Public awareness regarding AI's risks and responsible use must run in parallel with technological development. With ethics guiding innovation, AI can become a positive force for life improvement, with privacy, fairness, and accountability in an ever-evolving digital age. As AI revolutionizes industries and life, its ethics and privacy must be addressed in a manner that will enable long-term trust and viability to prevail. Keeping a delicate balancing act between accountability and innovation will enable AI to serve society and not invade individual freedom. With ethical development, governance, and awareness, AI can become a powerful ally that maximizes both development and humanity's values.

Text to Sign Language Conversion for Deaf and Hard-of-Hearing Students Through User-Friendly 3D Avatars

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Abstract

Communication difficulties affect the schooling, social skills, and language development of Deaf and Hard of Hearing (DHH) people. Current technologies convert text into sign language, but they are less useful for the Deaf community since they do not have 3D avatars that are easy to use and move naturally. The aim of this study is to create high-fidelity, AI-powered avatars with improved body language, gestures, and facial emotions for enhanced sign synthesis. The study employs a mixed-methods approach to assess the effectiveness, usability, and accessibility of deep learning algorithms for context-aware sign creation and avatar motion realism for DHH students.

Introduction

Communication is an interaction between people that takes many different forms since human characteristics are varied. To successfully accomplish goals, effective communication entails sharing ideas, thoughts, information, and knowledge. It is the process by which people communicate with one another, and it can happen both verbally and nonverbally. Non-verbal communication includes body language, facial expressions, and gestures, whereas verbal communication uses words, either written or spoken. Partial or total hearing loss causes deafness, which impairs an individual's ability to comprehend auditory input. These Deaf and Hard of Hearing (DHH) individuals often face communication challenges, impacting their language development, reading, writing, social interaction skills, and academic achievement. Damage or malfunction of the hearing apparatus may cause this condition, which can hinder language acquisition, especially verbal communication (Umah et al., 2024).

Since sign language allows for communication through facial expressions and movements rather than sound, it is essential to the Deaf community's communication systems. In addition to helping the Deaf community, this language enables communication between Deaf people and others (Othman & Jemni, 2011). The main sign language used by the Deaf community in Sri Lanka is called Sri Lankan Sign Language (SLSL). People frequently speak, read, and write in languages including Sinhala, Tamil, and English because Sri Lanka is a multicultural and multilingual nation. While deaf people use Sri Lankan Sign Language for communication, they read and write in Sinhala, Tamil, or English, just like their hearing counterparts (Sri Lankan Sign Language, 2018).

There are many variations of passages of Lorem Ipsum available, but the majority have suffered alteration in some form, by injected humour, or randomised words which don't look even slightly believable. If you are going to use a passage of Lorem Ipsum, you need to be sure there isn't anything embarrassing hidden in the middle of text. All the Lorem Ipsum generators on the Internet tend to repeat predefined chunks as necessary, making this the first true generator on the Internet. It uses a dictionary of over 200 Latin words, combined with a handful of model sentence structures, to generate Lorem Ipsum which looks reasonable. The generated Lorem Ipsum is therefore always free from

repetition, injected humour, or non-characteristic words etc..

Background and Research Problem

Two deaf individuals without other physical disabilities can communicate using sign language. However, communication becomes chalenging when a hearing person and a deaf person need to interact. In thesesituations, a translation process is necessary to convert the spoken language of the hearing person into sign laguage and vice versa. While a human translator can facilitate this translation, it is often costly and not always accessible. Therefore, there is a need for a practical solution to address the everyday communication needs of people in such scenarios.

The text-to-sign language conversion process consists of three key moules. First, text pre-processing analyzes and categorizes words mopho-syntactically using a language model. Next, sign sequence conversion transforms the processed text into sign sequences using various machine translation methods like RBMT, EBMT, SMT, HBMT, or NMT. Finally, sign glosses and visualization generate sign glosses, videos, or animated avatars to present the translated signs. (Kahlon & Singh, 2021). Research efforts have been extensively communicated regarding the detection of Sinhala Sign Language and convert it into text or speech in Sri Lanka. In 2016, studies focused on a sign language translation approach to the Sinhalese language using a Kinect based camera (Fernando & Wimalaratne, 2016). By 2020, advancements in machine learning facilitated real-time translation of Sinhala Sign Language into text using Convolutional Neural Networks (Hettiarachchi & Meegama, 2020). More recently, in 2022, a study explored the use of Leap Motion technology for translating Sri Lankan Sign Language into Sinhala text, showcasing continuous progress in this field (Rishan, Jayalal, & Wijayasiriwardhane, 2022). Contextually, many researches have been carried out for the methods of conversion of language of the hearing person in terms of text or voice to sign language. While existing methods translate hearing individuals' language to sign language, an optimized, user-friendly solution using a 3D avatar for effective translation and usability for the Deaf community remains undeveloped. Sign Language Machine Translation (SLMT) systems use avatars or glosses to represent signs, but real-world applications benefit more from virtual humans performing signs. Research supports avatar animation as the best method for sign synthesis, yet the Deaf community has not fully accepted it due to robotic and unnatural movements. Improving non-manual components like facial expressions and eye movements can enhance comprehension.

Literature Survey

In the research 3D Signing Avatar for Sinhala Sign Language (Punchimudiyanse & Meegama, 2015), the system is designed to animate Sinhala Sign Language words, phrases, and finger-spelled characters using a 3D avatar. The avatar focuses on upper body movements, incorporating 29 bones per arm for precise control It supports single-posture gestures, multi-posture gestures, and fingerspelling.Developed using Makehuman for avatar creation and Blender for rigging and animations, the system has been tested with 200 known SSL signs and 40 finger-spelled characters. However, it lacks support for animating facial expressions, which are crucial for many sign languages. Further development is needed to enhance realism and expand the gesture database. A 3D avatar-based model was developed to translate Sinhala text into Sinhala Sign Language by Thrimahavithana et al. (2019). The system was tested in an educational setting, comparing the traditional interpretation method with the proposed digital solution. Results indicated that students using the IT solution experienced a smaller average decrease in marks compared to the control group when compared to a previous test, suggesting improved understandability. The model supports multi-posture gestures and fingerspelling, enhancing its versatility. While the tool

was found to be effective, it remains limited in certain aspects, requiring improvements such as facial expressions and better body movement representation for more natural and effective communication.

Objectives

This study aims to achieve the objectives of identifying and evaluating the most suitable Sign Synthesis techniques for 3D avatar-based Sinhala Sign Language communication, determining the most appropriate Sign Sequence Conversion techniques for machine translation of Sinhala text to Sinhala Sign Language and developing and implementing a 3D avatar-based system that minimizes the issues identified in the previous studies for converting Sinhala text into Sinhala Sign Language.

Methodology

The research methodology follows a mixed-methods approach, integrating both qualitative and quantitative methods to assess the usability, accessibility, and effectiveness of text-to-sign language technologies, particularly focusing on 3D avatars for Deaf and Hard of Hearing (DHH) students. This approach ensures a comprehensive evaluation by capturing both statistical trends and in-depth user experiences. The high-level system methodology is depicted in Figure 1.

Data Collection

Semi-structured interviews, questionnaires, and surveys are used in the data collection phase. A wide sample of DHH students from different educational levels, as well as deaf school teachers, are the target of surveys and questionnaires designed to learn more about their preferences, difficulties, and experiences with the current text-to-sign language technology. This highlights the most and least useful elements of 3D avatars and focuses mostly on usability, accessibility, and efficacy. Selected participants are interviewed in a semi-structured manner to acquire qualitative understanding of their experiences. Through these interviews, user interactions with avatars, particular challenges encountered, and recommendations for enhancements were thoroughly examined.

Design Phase

In order to create user-friendly 3D avatars with improved capabilities for precise sign language representation, a participative design technique is used. To guarantee that the avatars faithfully capture sign language motions, facial expressions, and body language, this step entails cooperation between DHH students, 3D modeling experts, and sign language experts. These avatars' realism and naturalness are enhanced by generative AI models, giving users a more engaging and intuitive experience.

Prototype Feedback and Usability Testing

The prototype undergoes iterative refinement through user studies and feedback collection. DHH students interact with the avatars in controlled environments, performing tasks that involve text-to-sign language conversion. Key usability metrics are recorded, including task completion time, accuracy of sign language conversion, and user satisfaction. Observations and feedback are used to identify areas requiring improvement, ensuring the avatars meet the specific needs of the DHH community.

Optimization and Refinement

Based on usability testing results, the avatars are optimized to enhance their usability and effectiveness. This involves iterative testing and feedback loops to improve sign accuracy, movement fluidity, facial expressions, and customization options. Adjustments are made to enhance interaction quality, ensuring that the avatars effectively bridge communication gaps for DHH students.

Evaluation

Evaluation criteria include the system usability score, error rate in text-to-sign language conversion, and overall user satisfaction. Metrics such as the effectiveness of sign representation, ease of interaction, and user-friendliness are assessed to determine the success of the developed avatars. The final assessment ensures the 3D avatars provide an intuitive and efficient communication tool for DHH students and educators, promoting inclusivity in education.

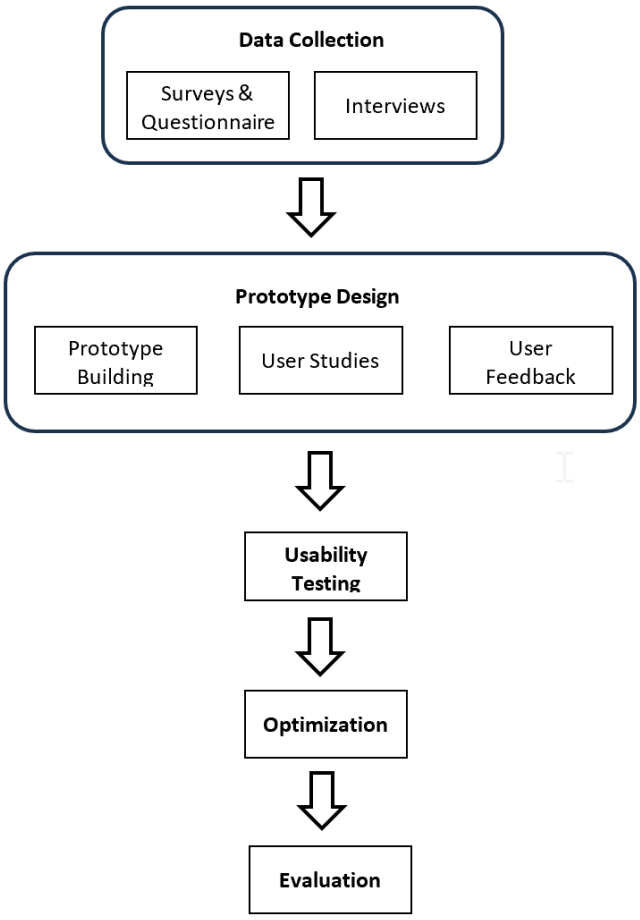

Figure 1 - High Level Research Methodology

Expected Research Contributions

This research focuses on advancing 3D avatar technology for sign language communication. It aims to develop high-fidelity, AI-driven avatars with improved gestures, facial expressions, and body language. The study also identifies usability guidelines for creating accessible, adaptable avatars. Deep learning techniques are applied to enhance avatar motion realism and context-aware sign generation. Additionally, the research explores scalability to support multiple sign languages, expanding beyond Sinhala Sign Language.

Conclusion

This study seeks to bridge the communication gap for individuals by enhancing the usability and effectiveness of 3D avatars for text-to-sign language conversion. By integrating AI-driven motion synthesis, facial expression modeling, and real-time usability testing, this research contributes to the broader field of assistive technology and accessibility. Future work will explore multilingual adaptation, real-time translation

capabilities, and further refinement of AI-based avatar modeling techniques.

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IoT Platform with Wearable Device for Tracking Dementia Patients

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Keywords

Dementia monitoring; Tracking system;LoRa;

Introduction

Dementia is a syndrome significantly impacting the daily lives of individuals, predominantly among the elderly population. It leads to a deterioration in cognitive capabilities, encompassing memory, concentration, reaction time, problem solving abilities, and difficulties in language articulation and word recall. Due to the impairments in spatial awareness, memory deficits, restlessness, and agitation commonly observed in individuals with dementia, there is a significant propensity for these patients to wander [1]. Wandering behaviour in dementia patients is a critical issue, as it can lead to disorientation, exposure to hazardous environments, and difficulties in returning home. Various types of wandering behaviours have been identified, such as aimless wandering, pacing, lapping, and shadowing. These behaviours can be triggered by anxiety, confusion, unmet needs, or an attempt to find a familiar location or person. Managing wandering behaviour requires continuous supervision, which places a substantial burden on caregivers [2]. To address this issue, This study mainly focuses on developing a wearable IoT (Internet of Things) device equipped with LoRa modules for real-time tracking and intelligent monitoring of dementia wandering patients [3, 4]. LoRa technology supports the development of low-energy, long-range Internet of Things (IoT) devices, and LoRa modules serve as essential components in our IoT platforms, facilitating the transmission of sensory data to central applications and enhancing remote monitoring capabilities [5]. The wearable device is being developed with a cost-effective approach, primarily aimed at middle and low-income countries with high dementia prevalence and prohibitive healthcare costs [6]. Designed for energy efficiency, these devices minimize the need for frequent charging, thereby ensuring consistent operation and improving practicality for dementia patients who may be prone to forgetting to recharge. The proposed IoT platfo rm provides continuous location monitoring, ensuring timely intervention by caregivers to prevent potential dangers. Continuous data on patient movement collected via wearable devices is transmitted to the cloud for machine learning, trajectory analysis, and anomaly detection to identify wandering scenarios [7, 8]. The IoT platform is engineered to integrate multiple wearable devices and sensors, forming a comprehensive medical suite for dementia patients. The integration of wearable devices allows the pre-processing of movement data on the device, reducing network latency and optimizing response times for critical alerts. The mobile application is designed with an intuitive user interface and incorporates features such as caregiver alerts, multi-user support, and historical tracking data visualization. The device integrates a temperature sensor to track body heat, detecting abnormal drops that may indicate health risks such as hypothermia. When a significant temperature reduction is detected, the device triggers an audible alert, ensuring immediate attention from caregivers. Given the sensitivity of patient location data, the system integrates end-to-end encryption added in the LoRa module and secure cloud storage to safeguard user privacy. Designed for middle and low-income countries, the solution prioritizes affordability by leveraging cost-

effective hardware and open-source technologies. The device enhances patient safety, promotes independent living, and reduces the risks associated with wandering behaviour in dementia patients. The design and development of the proposed IoT platform focused on user-centric design and design science research methodology [9]. From the perspective of dementia patients and caregivers, both quantitative and qualitative assessments will be conducted to evaluate the proposed platform. This research has the potential to improve the quality of life for individuals with dementia and simplify the responsibilities of family members, caregivers, and healthcare providers.

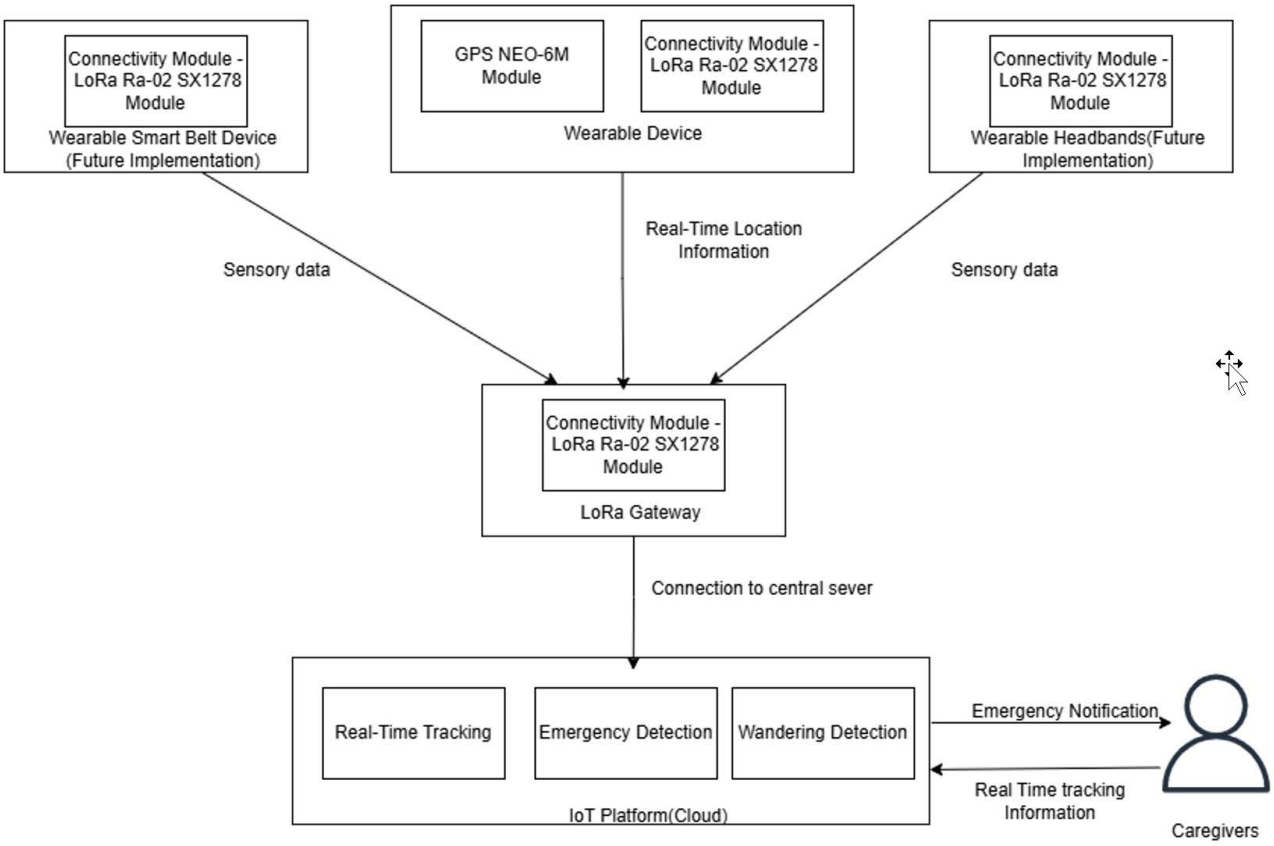

Figure 1 - High-Level Architecture of IoT Platform

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Automated Electricity Meter Reading System Using IoT

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Abstract

The conventional method of electricity meter reading in Sri Lanka requires manual intervention, where meter readers visit each location be it a factory, shopping complex, or residential property to record consumption. This approach is becoming increasingly inefficient with the country's growing population. Significant financial resources are allocated to manpower for this process, covering millions of residential and corporate establishments. Manual meter reading presents several challenges. One major issue is the risk of inaccuracies, whether due to human error or intentional misreporting, which can lead to financial inconsistencies and economic losses. Additionally, accessibility poses a problem when premises are unoccupied or inaccessible, estimates are often used, resulting in unreliable billing. Concerns related to privacy also arise, as some residents may be uncomfortable with external personnel entering their properties. Furthermore, environmental and safety factors can deter meter readers from accessing certain locations, further complicating the process. Another limitation of the traditional system is the delayed visibility of electricity usage. Consumers only receive their meter readings and the total bill at the end of the month, leaving them with no real-time insight into their consumption. With an automated system, users would have continuous access to their electricity usage and corresponding costs, enabling them to monitor and adjust their consumption proactively to manage expenses more efficiently. The need for automation in meter reading is evident. Implementing an automated system would enhance efficiency, eliminate opportunities for misreporting, and ensure accurate data collection without the constraints of manual intervention. Such advancements would not only streamline operations, but also empower consumers with real-time data, promoting better financial and energy management while supporting the country's evolving infrastructure needs. This research will follow a quantitative approach to ensure a thorough investigation into the feasibility and effectiveness of an automated electricity meter reading system in Sri Lanka. To begin, primary data will be gathered through surveys and interviews with electricity consumers. Surveys will measure the major challenges faced in the current system. Additionally, secondary data from case studies, government reports, and existing smart metering implementations in other countries will be analyzed to identify best practices and potential obstacles. A prototype of the automated system will be developed and tested under controlled conditions. This experimental phase will evaluate key performance metrics such as accuracy, efficiency, cost-effectiveness, and real-time data accessibility compared to traditional methods. This methodology is selected because it provides a comprehensive and evidence-based approach to evaluating the transition from manual to automated meter reading. By combining consumer feedback, expert opinions, real-world case studies, and experimental results, this research will offer a practical, data driven recommendation for implementation. The experimental component further ensures that the system is tested for real world viability before large scale adoption. The implementation that I am going do about is already a concept named AEMRS (Automated Electricity Meter Reading System) which has been revolving and discussed much

and many students have done research on, and implemented using various technologies such as ZigBee, GSM and many more. But the problem is that we see the proposed systems are not being implemented. So, I have come up with a user-friendly system which will provide better user experience when interaction is performed by IoT and communication is done by Bluetooth/Wi-Fi Direct. Currently, in Sri Lanka it is the same analog electricity meter that we use ever since the Ceylon electricity board came into existence. My intension is not to replace this analog meter with a completely brand new super expensive digital meter which cannot be afforded by the general public, rather to attach a proposed device between the analog meter unit and the electricity fuse board so that the exact electricity which passes through the meter box is the electricity which passes through the proposed device. This device is a simple low cost implemented device which consists if an Arduino board with a few integration devices in order to grasp the number of units passed through it and uses and LCD display to show the outstanding usage and current amount due. The proposed device has with it a radio frequency emitter to communicate with another module which would be placed in the isle of the street which would be the device which gets all the reading from the houses in the particular lane or street and with Bluetooth / Wi-Fi Direct technology it would push the results to the CEB IoT dash board. The system is designed in such a way that this process should be done manually, even though this could be automated. The process of manually doing this is recommended as a layer of security and maintenance where the meter reader here will be the one who will be the one responsible for any error report or any problems faced in the system because in the long run there would be issues arising and I find it more feasible for the push to be done manually and I find it suitable for the system to be stable in the long run. This second module is a lamp post attached with a solar power panel as source of energy and battery as a backup plan and another Arduino board which has a Bluetooth receiver which will receive the data from individual houses in the lane and the GSM module to communicate the date over the internet with IoT technology.

Combining Large Language Models with Predictive Analytics: A Review

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Abstract

Predictive analytics combined with Large Language Models (LLMs) indicates a revolutionary development in data-driven decision making. Because LLMs, like GPT-4 and BERT, are exceptionally proficient at analyzing and generating human-like texts, it is possible to extract important insights from enormous amounts of unstructured data. Predictive analytics makes predictions about the future based on historical patterns and are usually applied to structured data. Utilizing predictive analytics integrated with LLMs' natural language processing powers helps businesses bridge the gap between structured and unstructured data, producing predictions that are stronger in context and more accurate. Using this combination, businesses can boost market information, automate reporting, improve healthcare decision-making, improve consumer sentiment analysis, and streamline knowledge management. Nevertheless, issues including biases, computing power requirements, ethical considerations, and interpretability of the model remain arise. Addressing these issues and concentrating on upcoming advances, including domain specific LLMs and hybrid predictive models, the full capability of this integration will grow more approachable. The study highlights the significant impact that the combination of LLMs and predictive analytics may have on business intelligence and innovation, evaluating current systems, use cases, and future directions.

Keywords

Large Language Models (LLMs), Predictive Analytics, Data-driven decision making, Natural Language Processing (NLP)

Reimagining eBay: Enhancing User Experience through Comprehensive UX Design and Development

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Abstract

In today's fast-evolving digital marketplace, user experience (UX) plays a critical role in determining the success of e-commerce platforms. This study investigates the enhancement of eBay's user experience through a comprehensive UX design and development approach. Despite being a dominant force in the e-commerce industry, eBay's interface presents multiple usability challenges that hinder user engagement and satisfaction. The primary research question guiding this dissertation is: How can the user experience of eBay be significantly improved through a complete redesign of its website? To address this question, the study adopts a user-centered design (UCD methodology, which involves a systematic process of user research, persona creation, wireframing, prototyping, usability testing, and final implementation. The research began with an in-depth analysis of eBay's existing UX issues, leveraging heuristic evaluations, user surveys, and usability testing to identify critical pain points. These included navigation complexity, outdated visual design, inefficient search functionality, and cumbersome transaction workflows. Based on these insights, user personas were developed to better understand diverse customer needs and expectations Following the research phase, an iterative prototyping approach was employed, starting with low-fidelity wireframes and progressively refining them into a high-fidelity prototype. The prototype incorporated modern UX principles, such as intuitive navigation, responsive design, simplified checkout processes, and visually appealing aesthetics, ensuring a seamless and engaging experience. Additionally, accessibility enhancements were made to cater to users with diverse needs, aligning with WCAG (Web Content Accessibility Guidelines) standards. The functional website developed as part of this study serves as a proof of concept, demonstrating the impact of an optimized UX design on user engagement and satisfaction. Comparative usability testing was conducted between the existing eBay interface and the redesigned version, with participants providing quantitative and qualitative feedback. The results revealed significant improvements in key functionality aspects, usability & satisfaction scores, and overall user experiences. Users reported a more streamlined and enjoyable experience, particularly appreciating the intuitive navigation, aesthetically pleasing interface, and reduced cognitive load in completing transactions.The findings from this research highlight the importance of a holistic UX approach in optimizing e-commerce platforms. By addressing usability issues and aligning with modern design trends, the study demonstrates that a comprehensive UX overhaul can significantly enhance user engagement, conversion rates, and overall platform efficiency. Furthermore, these insights provide a valuable framework for other e-commerce platforms seeking to improve their user experience through strategic UX design methodologies. In conclusion, this dissertation establishes that effective UX design is not merely a visual enhancement but a fundamental factor in the success of digital platforms. The redesigned eBay website sets a new benchmark for usability in e-commerce, advocating for a user-first approach in web design and development. Future work may explore the integration of AI-driven personalization, advanced recommendation systems, and augmented reality (AR) features to further elevate the shopping experience

This study contributes to the growing body of research in human-computer interaction (HCI), UX design, and e-commerce usability, emphasizing that user-centered innovations are crucial for sustaining competitiveness in the digital marketplace.

Keywords

User Experience (UX), eBay Redesign, Usability, E-Commerce, User-Centered Design, Human-Computer Interaction (HCI)

An Empirical Study on a Hybrid System of Passive Optical Network and Radio Frequency for Telco Connectivity

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Abstract

The rapid evolution of telecommunication networks has led to increased demand for high-speed, reliable, and cost-effective connectivity solutions. Among various technologies, Passive Optical Networks (PON) and Radio Frequency (RF) wireless networks have emerged as dominant solutions for broadband infrastructure. Despite their advantages, both technologies face significant challenges: optical fiber networks require substantial investment and lengthy deployment lead times, while RF networks are constrained by coverage limitations and spectrum availability. This research explores the feasibility of a hybrid system integrating PON and RF technologies to optimize telecommunication network deployments, focusing on the need and possibility of such an implementation. The study critically analyzes the strengths and limitations of PON and RF-based connectivity, identifying gaps in existing implementations that hinder efficient broadband expansion. High costs and time-consuming deployments in optical fiber networks often restrict their reach, particularly in rural and underdeveloped regions.Meanwhile, RF technologies, although flexible and scalable, struggle to provide sustained high-capacity connections comparable to optical fiber-based solutions. To address these challenges, the proposed hybrid approach leverages the advantages of both technologies, utilizing optical fiber for core and backhaul networks while incorporating RF solutions for last-mile connectivity. This integration aims to enhance deployment efficiency, reduce costs, and improve service quality. A comprehensive literature review assesses prior research on broadband technologies, infrastructure deployment strategies, and hybrid network solutions Key theoretical frameworks, including network architecture models and broadband deployment strategies, form the foundation for evaluating the feasibility of the hybrid system.Given the high costs and regulatory challenges associated with physical prototyping, this study employs a secondary data analysis approach, combining case studies of existing PON and RF deployments with simulations to validate the proposed model's performance. Regulatory, economic, and operational factors influencing network rollouts are also considered. By integrating RF technology with PON in last-mile access networks, the research demonstrates the potential to reduce implementation costs and lead times while maintaining high service quality. This approach addresses critical challenges faced by telecommunication service providers, particularly in expanding broadband access to underserved regions. The findings are expected to contribute to the field of telecommunications by offering an alternative model that enhances efficiency, scalability, and economic viability.This research is significant for policymakers, telecommunication engineers, and service providers seeking to optimize network infrastructure while balancing cost and performance Future studies may extend this work by developing real-world pilot implementations to validate the proposed model's effectiveness in diverse geographic and economic contexts. The hybrid system represents a novel contribution to the field, offering a practical solution for bridging the digital divide and advancing sustainable development.

Ethical Considerations in Using Learning Analytics for Student Monitoring: A Set of Guidelines for Stakeholders

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Keywords

Learning Analytics, Privacy in education, Student Monitoring, Data Privacy, Algorithmic Bias, Data Security, Ethical Framework, Student data privacy, Ethical guidelines for academics

Introduction

The growing adoption of Learning Analytics (LA) in education allows institutions to monitor and analyze student learning behaviors, improving personalization and decision-making. However, its use raises several ethical concerns, particularly regarding privacy, fairness, and student rights. In order to investigate these issues, this study focuses on bias, data violence, and the openness of automated decision-making.

It examines the perspectives of key stakeholders—students, educators, and administrators—on the ethical implications of LA and evaluates the effectiveness of legal frameworks such as GDPR and FERPA. In order to provide an ethical framework that guarantees responsible implementation while safeguarding student privacy and fairness, the research attempts to uncover loopholes in current rules. In the end, by highlighting the significance of trust, equity, and responsibility in learning analytics, this study adds to the continuing conversation about ethical technology employed in education.

Review of Literature

Learning analytics (LA) is increasingly used in education to track student progress, predict outcomes, and improve interventions. However, ethical concerns such as data privacy, algorithmic bias, and misuse remain critical challenges. While existing research

addresses issues related to data governance, informed consent, and transparency, a comprehensive ethical framework for educators is still lacking.

Many academics emphasize how crucial adherence to rules and regulations is. Prioritizing student agency, openness, and acknowledging student identity as a dynamic concept are among the six guiding principles that Slade and Prinsloo (2013) suggest for the ethical application of LA. Restricting access to student data, maintaining ethical data gathering procedures, gaining informed permission, and fairly allocating the advantages of learning analytics are the four main privacy problems identified by Rubel (2016). The difficulty of striking a balance between student privacy and focused institutional support is further examined in a 2022 white paper on LA ethics.

Broader ethical perspectives also emerge in the literature. Buchanan (2011) stresses the need for research ethics to evolve alongside technological advancements, while Ferguson (2019) categorizes over 30 ethical concerns, including consent, equality,

and data ownership. Studies on Multimodal Learning Analytics (MMLA) argue that conventional ethical frameworks are insufficient for handling emerging technologies like facial recognition and EEG tracking, calling for more context-specific ethical guidelines.

To address these issues, some scholars offer ethical frameworks. While West et al. (2016) create a four-step ethical decision-making model for LA implementation, Roberts et al. (2016) present a matrix to analyze ethical concerns from the viewpoints of various stakeholders. Furthermore, in order to guarantee responsible data usage in institutions of higher learning, Jensen (2015) supports the establishment of a Data Governance committee.

Student perspectives also provide valuable insights into ethical considerations. Karimov et al. (2020) find that while students recognize the usefulness of engagement data for personal and instructor dashboards, they express strong concerns over privacy, particularly regarding chat participation and facial recognition. The study highlights the need for clear communication, informed consent, and robust data protection mechanisms in LA systems.

The literature emphasizes the importance of active stakeholder participation, ethical transparency, and regulatory alignment in learning analytics. Despite LA's enormous potential to improve education, educational institutions must carefully weigh its advantages against their moral commitments to uphold student autonomy, trust, and data protection.

Key Findings

The literature on learning analytics (LA) highlights several ethical challenges and areas for improvement:

1. Privacy & Data Security – The use of technologies like facial recognition and GPS tracking raises concerns about data being collected without students' consent. Ensuring transparency and granting students control over their data is crucial.
2. Ethical Standards – A standardized ethical framework for LA is lacking. Scholars recommend implementing adaptable guidelines, such as the PANDORA ethics-by-design checklist, to promote responsible use.
3. Power & Monitoring – LA can create power imbalances, making students feel constantly monitored. There is also a risk of reinforcing biases or misinterpreting data, leading to unfair outcomes.
4. Moral & Ethical Responsibility – Some researchers advocate for treating LA as a "moral practice" that prioritizes student well-being and ethical decision-making rather than merely focusing on data analysis.
5. Comprehensive Ethical Approach – Ethical discussions should extend beyond privacy to consider the varied effects of LA on different student groups and educational settings.
6. Empirical Research Gap – More real-world case studies are needed to bridge the gap between theoretical ethical frameworks and their practical implementation.

Critical Analysis

Research on learning analytics (LA) highlights its potential to enhance student outcomes while raising critical ethical concerns. Key issues include:

1. Privacy & Data Security – Ensuring transparency in data collection, especially with technologies like GPS tracking and facial recognition. Students should have control over their data, with informed consent being essential.
2. Ethical Guidelines – A universally accepted ethical framework for LA is lacking, prompting scholars to call for adaptable guidelines addressing privacy, consent, and transparency.
3. Power & Oversight – Continuous student monitoring may create ethical challenges, reinforcing biases and limiting autonomy, particularly in predictive analytics used to identify at-risk students.
4. Moral Responsibility – Learning analytics should be seen as a moral practice that prioritizes student well-being rather than solely focusing on data analysis.
5. Inclusive Ethics – Ethical considerations should go beyond privacy, accounting for the diverse impacts of LA across different educational environments.

The literature emphasizes the need for adaptable, student-centered ethical frameworks to ensure responsible implementation of learning analytics.

Conclusion

Learning analytics holds significant promise for improving educational outcomes, but its increasing use raises important ethical issues that must be addressed. Key concerns include privacy, consent, transparency, and the balance between surveillance and student autonomy. Although existing frameworks and principles guide to some extent, there is still a lack of consensus and clear, actionable ethical guidelines.

The creation of more useful, context-specific ethical standards that may be successfully applied in a variety of educational contexts is crucial to the future. To guarantee that learning analytics are applied responsibly, cooperation amongst different stakeholders—students, teachers, administrators, and legislators—will be necessary. Learning analytics systems should be designed, implemented, and evaluated with ethical issues in mind. To create systems that not only enhance student performance but also safeguard students' rights and privacy, a thorough approach that blends technological and moral viewpoints will be essential. To link theoretical ethical frameworks with practical application and evaluate their efficacy in various educational contexts, more empirical research and case studies are required.

Future considerations

Future considerations for this review could include the following areas:

1. Creation of a Unified Ethical Framework: There is a need to develop a comprehensive and adaptable ethical framework for learning analytics that can be broadly implemented across institutions. This framework should cover both data privacy and broader ethical concerns such as fairness, transparency, and accountability, ensuring all involved parties—including students, faculty, and administrators—understand their roles and responsibilities.

2. Engaging Stakeholders in Ethical Dialogue: Further research should focus on how to better involve students, faculty, and other stakeholders in conversations about learning analytics. It's crucial to incorporate their concerns about privacy, autonomy, and informed consent into the design and implementation of data governance

policies.

3. Global Alignment of Ethical Policies: Given the global use of learning analytics, it is critical to investigate how ethical guidelines might be adapted to various legal and cultural contexts. This will help guarantee that, despite differences in educational institutions and data practices, students' rights and data protection requirements are upheld internationally.

4. Mitigating Algorithmic Bias and Ensuring Fairness: More research is needed into how algorithms in learning analytics can be designed to reduce bias and enhance fairness. This could include developing strategies to ensure that the data used is representative and doesn't reinforce existing inequalities in education.

5. Empirical Studies and Case-Based Research: Future research should focus on empirical, real-world investigations to gain a deeper understanding of the moral dilemmas that educational institutions confront while utilizing learning analytics. Case studies may offer important insights into the practical applications of ethical concepts in various educational settings.

6. Ethical Adaptation to Emerging Technologies: As new technologies such as multimodal learning analytics, AI, and facial recognition become more integrated into educational practices, research should examine their impact on student privacy and autonomy. Future studies could also look into how these technologies can be used responsibly while minimizing risks to students.

Long-Term Evaluation of Impacts

Research should explore the long- To better comprehend the ethical conundrums that educational institutions face when using learning analytics, future research should concentrate on empirical, real-world studies. Case studies may provide valuable information about how ethical ideas are used in real-world situations in a variety of educational contexts.

In summary, the future of learning analytics in higher education depends on continuous ethical reflection, active involvement of all stakeholders, and data-driven research to ensure that the advantages of these technologies are realized without infringing on students' privacy and rights.

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Challenges and Obstacles in Implementing Learning Analytics: A Study in the Educational Context

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Keywords

Data Analytics, Challenges, Engagement, Culture, Limitations

Introduction

Traditional cyber defense measures often prioritize technical robustness over user experience, leading to reduced efficiency due to user error, non-compliance, or adoption issues. (Edfors & Sverreson, 2022). For instance, a 2022 study by Cybersecurity Ventures reported that 82% of data breaches involved human-related errors, highlighting the importance of designing security systems with users in mind. The escalating reliance on cybersecurity applications requires the integration of user-centered design (UCD) principles to improve accessibility and usability. (Edfors, E., 2022). Key UCD principles, such as iterative design, user feedback, and usability testing, are explored to demonstrate their impact on security systems. This study explores the critical role of accessibility and usability in cybersecurity applications, emphasizing how User-Centered Design (UCD) can address human-centered security measures. (Edfors & Sverreson, 2022).

Learning Analytics (LA) is the application of data-driven insights to enhance institutional decision-making, instructional practices, and student learning. Despite its potential benefits, adoption is hampered by a variety of factors, particularly in developing countries. The challenges include regulatory gaps, stakeholder resistance, data privacy concerns, low levels of digital literacy, and inadequate technical infrastructure.

This research examines organizational, ethical, and technical constraints to examine these barriers and offers strategies for effective LA implementation. The goal is to provide advice on how to get over these challenges in order to enhance educational outcomes and institutional efficacy. The goal of the study is to identify the primary barriers to LA adoption and to offer potential solutions.

Review of Literature

Although learning analytics, or LA, has many advantages for both students and teachers, implementation of LA is fraught with difficulties, especially in poor countries. LA has developed into a multidisciplinary area that integrates data science, artificial intelligence, and psychology since its launch at the Learning Analytics Conference in 2010 (Siemens, 2013). Stakeholder resistance, privacy and ethical issues, and resource constraints are impeding broad adoption despite increasing corporate interest and scholarly initiatives (Alzahrani et al., 2022). Adoption is further limited by imprecise analytics methods, scalability problems, and a lack of investment in human and technological resources (El Alfy et al., 2018).

Although LA has potential, the Society for Learning Analytics Research (SoLAR, 2021)

notes that institutional opposition, poor pedagogical integration, poor communication, and resource limitations are major roadblocks. For institutional acceptability, ethical factors such as data protection, openness, and governance are essential (Tzimas & Demetriadis, 2021). For sustainability, LA must be in line with instructional theories, systematic implementation frameworks, and student participation (Tsai et al., 2020). Stakeholder interaction, cultural evaluation, and strategic planning are necessary to ensure institutional stability, which is still a challenge (Ferguson, 2014). To guarantee responsible implementation, ethical issues including permission and data ownership must be addressed (Nunn et al., 2016).

Staff ability, money, infrastructure, monitoring, and ethics are the five main obstacles to LA adoption in South Africa, according to Ngqulu (2018). Implementation is hampered by fragmented infrastructure, inadequate finance, and inadequate personnel training. Monitoring is acknowledged as essential, although it is not regarded as a major barrier. Although acknowledged, ethical problems are lessened by current regulations. Training initiatives, government backing, system integration, and supervision are necessary for effective adoption.

Paolucci et al. (2024) explore the potential of big data analytics in K–12 education, whereas Chaurasia et al. (2018) focus on its use in higher education. LA has the potential to improve educational decision-making by promoting data literacy, ensuring ethical usage, and aligning technology with instructional paradigms. Despite barriers including data collection costs, biases, and privacy issues, LA can enhance teaching practices, student performance evaluation, and the adoption of instructional materials at the district and institutional levels.

Additional barriers to LA success are highlighted by Misiejuk et al. (2023), such as difficulties integrating analytics into courses, limited access to commercial data, and inadequate alternative data gathering techniques. In order to address these problems, it is necessary to evaluate the availability and granularity of data, take into account alternate data sources, integrate analytics with surveys and conventional evaluations, and make sure that the tools are in line with educational objectives.

According to Clark, Liu, and Isaias (2020), IT readiness, organizational strategy, performance measurement, data quality, and human skills are all critical success factors (CSFs) for LA adoption. The foundation of dependability, honesty, and user confidence is data quality. Effective implementation requires a trained staff, institutional support, and IT readiness. Empirical testing of LA systems is currently limited by scalability, deployment circumstances, and assessment efficiency; these issues must be addressed in addition to ethical and privacy considerations.

Reviewing LA interventions, Wong & Li (2019) concentrate on data types, methodology, results, and implementation issues. There is increasing interest in employing LA to improve student progress and address learning challenges, as evidenced by the literature's identification of 24 intervention options, which surpasses previous studies. These treatments' data come from both in-person and virtual learning settings. The cost-effective acquisition of the data required to guarantee large-scale viability is still a major obstacle.

Higher education institutions must address privacy and data security issues. According to Oakleaf (2016), controlling these risks requires robust data rules and processes. Institutional culture, organizational readiness, and data quality provide further difficulties. For LA adoption to be effective, a data-driven decision-making culture supported by the right rules, knowledge, and infrastructure must be established.

The application of Learning Analytics (LA) technology in Brazil is examined by Menezes et al. (2024), who highlight potential benefits such student monitoring and intervention planning. Nonetheless, problems including a lack of student input, financial limitations, and sociodemographic disparities still persist. Future research should concentrate on Latin America.

Meenakumari & Kudari (2015) stress the need of data protection measures, clear regulations, and institutional data literacy. They suggest developing moral norms, analyzing diverse data sets, and researching the sciences more closely. Big data analytics may be used to forecast student dropout rates and academic failure.

In conclusion, the material mentioned above indicates that although LA has the potential to transform education by offering data-driven insights on student performance and instructional efficacy, many obstacles need to be removed.

Critical Analysis

Critical Analysis of Challenges in Implementing Learning Analytics:
Learning analytics integration presents a number of challenges, including data-related issues, institutional resistance, financial limitations, privacy and ethical issues, and stakeholder involvement. A thorough examination of these problems shows their individual importance as well as their combined impact on educational institutions.

Resistance and Involvement of Stakeholders:
Effective implementation of learning analytics is hampered by the opposition and challenges faced by stakeholders, including educators, administrators, lawmakers, and students. Effective stakeholder participation is essential, but it is sometimes impeded by misinformation, resistance to change, concerns about an increased workload, and challenges acclimating to new technologies. This reluctance stems from a lack of institutional efforts to engage all relevant parties and a lack of knowledge about the benefits of learning analytics.

Ethical and Privacy Considerations:
Privacy and ethical concerns are major barriers to learning analytics adoption. Significant challenges exist in the areas of security, governance, transparency, and data privacy. Ethical dilemmas surrounding the collection and use of data, such as securing authorization, safeguarding data, and implementing preventative measures, underscore the necessity of comprehensive data governance legislation. Furthermore, building trust in learning analytics initiatives requires maintaining open channels of communication with stakeholders and ensuring transparency in the use of data.

Financial Constraints and Resource Deficiencies:
One of the biggest barriers to the development of learning analytics is the lack of enough funding for research and technological development. The significant costs of engaging employees, constructing a robust infrastructure, and acquiring and maintaining learning analytics technologies limit sustainability and scalability. Without sufficient financing, institutions struggle to adopt innovative data-driven teaching strategies, which limits the potential benefits of learning analytics.

Institutional and Organizational Barriers:
Institutional resistance and organizational readiness are critical to the successful application of learning analytics. Poor pedagogical integration, a lack of staff capacity, and insufficient data literacy training are some of the problems that lead to institutional stagnation. It is difficult to properly integrate learning analytics because of these issues,

which are exacerbated by a lack of strategic planning and cultural resistance.

Data Quality and Utilization Issues:
The effectiveness of learning analytics is significantly impacted by the reliability and accessibility of data. Problems including poor data collection methods, poor data quality, and difficulties managing large datasets impede progress. Without clear procedures for gathering and analyzing data, institutions struggle to glean insightful information that enhances student learning outcomes.

Other Considerations and Implementation Challenges:
The efficacy of learning analytics is further hindered by inadequate communication strategies and inefficient student feedback mechanisms. Widespread adoption is nevertheless hampered by scalability concerns and the challenges of integrating learning analytics into diverse educational environments. Furthermore, the lack of a strong pedagogical foundation for learning analytics reduces its potential to greatly enhance education.

Many institutions find it challenging to assess the performance of learning analytics initiatives because of unresolved data ownership concerns, the requirement for actionable insights, and the development of relevant regulations. Educational inequality is further intensified by sociodemographic differences in learning analytics access and advantages. A general lack of understanding of the importance of learning analytics further restricts its wider application.

Conclusion

There are several interconnected problems with learning analytics deployment. A comprehensive plan to address these obstacles must include strong ethical and privacy protections, active stakeholder participation, more financing, institutional preparedness, and improved data management practices. Collaboration between academic institutions, lawmakers, and tech businesses is crucial to overcoming these challenges and achieving learning analytics' full potential in enhancing educational outcomes.

Future Direction

Future research should concentrate on creating frameworks that are appropriate for a particular setting, bolstering data security and ethical norms, and boosting stakeholder participation in order to enhance the application of learning analytics (LA) in developing nations. Enhancing technology infrastructure and accessibility, integrating LA into educational practices, and conducting long-term effect research are all essential. To further guarantee LA's long-term survival, scalable and sustainable implementation strategies must be looked at.

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User-Centered Design in Cybersecurity Applications: Analyzing the Role of Accessibility and Usability

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Abstract

Traditional cyber defense measures often prioritize technical robustness over user experience, leading to reduced efficiency due to user error, non-compliance, or adoption issues. (Edfors & Sverreson, 2022). For instance, a 2022 study by Cybersecurity Ventures reported that 82% of data breaches involved human-related errors, highlighting the importance of designing security systems with users in mind. The escalating reliance on cybersecurity applications requires the integration of user-centered design (UCD) principles to improve accessibility and usability. (Edfors, E., 2022). Key UCD principles, such as iterative design, user feedback, and usability testing, are explored to demonstrate their impact on security systems. This study explores the critical role of accessibility and usability in cybersecurity applications, emphasizing how User-Centered Design (UCD) can address human-centered security measures. (Edfors & Sverreson, 2022). This study analyzes the application of "User Centered Design" (UCD) discipline in the context of two case studies: 'Microsoft Password-less Authentication' and 'Apple Face ID: Secure & Accessible Biometric Authentication.' Through this analysis, the study explores how UCD discipline enhances both usability and accessibility in modern authentication. Additionally, the study examines Microsoft's password-less authentication's ability to eliminate traditional passwords by leveraging biometric verification and multi-factor authentication to improve both security and usability. Also, the study assesses how UCD principles, such as iterative prototyping, incorporating user feedback, and usability, drive the adoption of password-less authentication while addressing security concerns such as phishing and credential theft. Precedented research has shown that applying iterative design processes in cybersecurity applications improves both security adoption and usability. (Edfors & Sverreson, 2022). Microsoft Password-less Authentication removes the need for traditional passwords by utilizing biometric verification and multifactor authentication, enhancing security while streamlining the authentication process. Similarly, Apple Face ID provides seamless biometric authentication, reducing friction and improving the user experience without compromising security. This study also considers the ethical and privacy implications of these authentication methods, particularly regarding data storage and potential misuse. This study uses a mixed-method approach, combining qualitative and quantitative analyses. The methodology includes a sample of 45 participants representing a diverse pool of users with varying levels of cybersecurity experience, conducting user perception surveys, usability testing sessions, then a comparative case study analysis of Microsoft Password-less Authentication and Apple Face ID to evaluate the effectiveness of UCD in the aforementioned security measures. By utilizing disciplines and iterative process from User Experience Design (UXD) for cybersecurity measures and real-world implementations, this study evaluates the need for continued adoption of User Centered Design in authentication solutions. The study's unique contribution lies in its demonstration of how UCD principles can bridge the gap between security and userability, offering a potential structure for future authentication solutions. Recommendations are to explore ethical and privacy considerations such as informed consent and biometric data security, and the emerging threats of AI-driven authentication mechanisms.

Keywords

User-Centered Design, Cybersecurity, Accessibility, Usability, Universal Design Principle

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Artificial Intelligence and Personalized Learning for Education: Innovations and Future Directions

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Abstract

By increasing student engagement, streamlining learning pathways, and boosting results, the combination of AI and customized learning is transforming education. Diverse pupils can benefit from personalized learning experiences made possible by technologies such as adaptive learning platforms and intelligent tutoring systems. However, there are obstacles to integrating AI in education, especially in poor nations, including issues with data privacy, a lackluster digital infrastructure, and uneven access to resources. This research looks at the possibilities of AI-driven learning, the obstacles to its uptake, and implementation tactics. Stakeholders may utilize AI to develop more effective and inclusive learning environments by solving these challenges. For educators, academics, and policymakers looking to use AI to enhance education, the findings offer insightful information.

Keywords

AI in Education, Learning Analytics, Digital Learning Environments, Challenges in AI Adoption. Future of AI in Education

Introduction

AI is revolutionizing education by facilitating personalized learning through intelligent tutoring systems and learning analytics, enhancing student engagement and academic outcomes. However, its adoption in underdeveloped regions faces obstacles like inadequate digital infrastructure, data privacy issues, and resistance to new technologies. This study examines AI's potential in education, the challenges of implementation, and strategies for overcoming these barriers to create inclusive and effective learning environments. The insights gained aim to assist educators, researchers, and policymakers in optimizing AI's role in education.

Research Questions

1. In what ways does AI enhance personalized learning experiences in education?
2. What are the primary challenges and barriers in implementing AI-driven personalized learning, especially in developing regions?
3. How can AI technologies be seamlessly integrated into existing educational systems while preserving human-centered learning approaches?
4. What strategies can be adopted to ensure fair and inclusive access to AI-powered personalized learning tools in diverse educational settings?
5. How do AI-driven learning analytics and adaptive learning systems influence student engagement and academic achievement?
6. What policies and frameworks can support the sustainable and scalable integration of AI in personalized education?

Main Aim

This research aims to explore the impact of Artificial Intelligence (AI) on personalized learning and identify the key challenges associated with its adoption.

Research Objectives

1. To examine how AI enhances personalized learning experiences in education.
2. To identify the key challenges and barriers in implementing AI-driven personalized learning, particularly in developing regions.
3. To explore effective strategies for integrating AI technologies into existing educational systems while maintaining human-centered learning approaches.
4. To propose solutions for ensuring fair and inclusive access to AI-powered personalized learning tools in diverse educational settings.
5. To assess the impact of AI-driven learning analytics and adaptive learning systems on student engagement and academic performance.
6. To recommend policies and frameworks that support the sustainable and scalable integration of AI in personalized education.

Literature Review

The advantages, difficulties, and methods for using AI to customized learning are examined in this research. It investigates the ways in which artificial intelligence (AI) tools, including learning analytics, adaptive learning platforms, and intelligent tutoring systems, might enhance academic performance and student engagement. The report draws attention to the barriers to AI adoption, especially in developing nations where problems including poor digital infrastructure, restricted accessibility, and data privacy concerns present serious difficulties. With an emphasis on individualized learning and the potential for AI's scalability in international educational systems, the goal is to assist academics, educators, and policymakers in creating inclusive, ethical, and sustainable methods to incorporating AI in education.

Scope of the Research

While AI technologies are widely used in education in industrialized nations, their acceptance is still relatively low in impoverished ones. Even while AI-driven learning is widely used in wealthier countries, there are still a number of difficulties and barriers. The incorporation of AI should be encouraged worldwide due to its significant advantages for both students and teachers. Even though a lot of study has been done on AI in education, there aren't many studies that particularly focus on developing nations.

The report emphasizes AI's transformative potential in education while acknowledging significant challenges and ethical quandaries.

1. AI as a Tool to Enhance Learning AI aids educators by enabling more tailored and accessible learning; nonetheless, human connection remains crucial for fostering intellectual and moral development (Pratama et al., 2023). By tailoring training to each student's requirements, AI-driven adaptive learning enhances engagement and learning outcomes (Claned, 2024; Khan, 2023).
2. Predictive models, real-time feedback, and immersive technologies all optimize learning experiences (Strielkowski et al., 2024; Tapalova & Zhiyenbayeva, 2022). Impact on Student Motivation and Psychology o AI-powered personalized learning encourages

autonomy, motivation, and engagement through the use of self-determination theory (Ellikkal & Rajamohan, 2024). Personalized learning and interactive AI technologies enhance overall learning outcomes and boost intrinsic motivation (Ng et al., 2025).

3. Difficulties and Moral Aspects Algorithmic prejudice, data privacy issues, deficiencies in teacher training, and uneven access are some of the challenges facing the adoption of AI (Dembe & Kiu Publication, 2024; Singh et al., 2024). Active stakeholder participation in system design is necessary to provide user control, trust, and dependability in AI systems (Alfredo et al., 2024).
4. Policy, Governance, and Future Prospects
    - Clear policies, continual professional development, and cooperation between educators, technologists, and legislators are necessary for the ethical integration of AI (Ayeni et al., 2024; Bhutoria, 2022).
    - Sri Lanka and other nations are investing in AI-driven economic growth, with a strong emphasis on responsible development and strategic planning (CFSAI, 2024).

To sum up, AI is transforming education by providing individualized, effective, and captivating learning experiences. But in order to optimize its advantages, ethical supervision, responsible execution, and stakeholder

Methodology

Based on the secondary data from research papers, case studies, review articles, and electronic journals. This study's research methodology is qualitative. This approach offers a thorough grasp of LA adoption without necessitating the gathering of novel data by examining previous secondary sources such as research papers, case studies, review articles. Thematic analysis has used which will helpful for effective analysis of the secondary data.

Critical Analysis of the Literature Review

The following significant themes about AI in education are outlined by the secondary data provided:

- Personalized Learning: AI makes it possible to create learning experiences that are tailored to each student's needs, improving academic performance and engagement.
- Ethical and Social Issues: When talking about the use of AI in education, issues like algorithmic bias, data privacy, and justice are important points of debate.
- Human-AI Collaboration: Although AI is a potent instrument, teachers continue to play a critical role in providing direction, motivation, and moral ideals in the classroom.
- AI-Driven Innovative Changes: AI is transforming education through data analytics, immersive environments (like VR/AR), and adaptive learning technologies, opening the door to revolutionary educational reforms.
- Global and regional challenges: AI's effects are felt differently in different places, with underdeveloped nations experiencing unequal access to infrastructure and resources. Effective AI application requires robust legal and regulatory frameworks.
- Prospects for Future Research: To strengthen human-centered design, advance AI algorithms, and close the knowledge gap between theory and practice in education, further research is required.

In conclusion, despite AI's enormous promise for innovative education and individualized learning, its integration requires careful consideration of global inequities, teacher participation, ethical issues, and future developments.

Conclusion

AI has the potential to completely transform education by providing individualized learning opportunities that raise academic achievement and student engagement. However, obstacles including poor infrastructure, worries about data privacy, and reluctance to accept new technologies are impeding its development in underdeveloped nations. Clear laws and governance are necessary to handle ethical concerns like algorithmic bias and data privacy in order to fully realize AI's promise. Ensuring fair access to AI technologies requires the implementation of scalable and sustainable solutions. Collaboration between educators, legislators, and technologists is essential for effective integration, striking a balance between human-centered learning and technical innovation.

Future Directions

AI in education offers great potential for improving effectiveness, accessibility, and personalized learning. However, several key areas require further research to ensure its successful and responsible implementation:

- Bridging the Digital Divide: To guarantee fair access to AI-powered learning materials and aid in closing educational inequalities, research should concentrate on removing the infrastructural and technology obstacles in developing nations.
- AI-Enhanced Education: Studies should investigate how AI can support adaptive learning models to accommodate various learning preferences, while ensuring that human oversight is preserved in the educational process.
- Assessing Long-Term Impact: To ensure AI's long-term effectiveness in education, longitudinal studies are required to assess the technology's long-term impacts on student engagement, academic achievement, and retention.
- Promoting Multidisciplinary Collaboration: In order to develop thorough laws for the use of AI in education, future study should promote cooperation between educators, legislators, engineers, and psychologists.

Addressing these challenges will help unlock AI's full potential, leading to better learning outcomes and more inclusive, high-quality educational experiences.

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Harnessing Machine Learning and Deep Learning to Anticipate Stock Price Variations Post-New Product Launches

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Abstract

There are many algorithms that work behind stock market analysis, and hence stock market trading has turned out towards the greatest and most existing activity when one speaks towards the financial markets. Uncertainty and volatility in the prices of the stocks keep on making the investor look for means to predict future trends in order to avoid losses and get the maximum possible profits; however, one cannot deny that, up till now, no such technique can predict the upcoming trends in the markets with 100 percent accuracy, yet various methods are being experimented for improving the predictive performance of models to a higher extent. In the past few years, there are numerous algorithms deployed for stock price prediction because of rapid progress of machine learning and deep learning. The research has concentrated on five algorithms: K-nearest neighbors, linear regression, support vector regression, decision tree regression, and long short-term memory (LSTM) to predict the stock prices[1] of 12 leading Indian stock market companies. With an extensive background research done in and around an attempt to apply ML in the stock markets, this particular study has been indeed an exhaustive one-leveraging precise and quantitative data of 12 mentioned companies acquired through 7 years of experience. In addition, other efficient and robust approaches which are used to forecast market trends are discussed. At the same time, a detailed stepwise methodology for obtaining the results is discussed in this paper. In addition to that, a comparative analysis of the performances of the algorithms mentioned for stock price prediction has been performed showing the results in a tabulated and graphical form so that it is easier to comprehend.

Keywords

Machine Learning, Deep Learning ANN (Artificial Neural Network), LSTM (Long Short Term Memory) SVM (Support Vector Machine) algorithm,ML(Machine Learning), DL(Deep Learning)[6], RNN(Recurrent Neural Network), NPA (New Product Announcement)

Introduction

The stock market has long been characterized by unpredictability and high volatility, making it difficult for investors to make accurate predictions. Stock prices continue to fluctuate depending on political events, economic developments, global crises, public opinion, and other factors. For example, the pharmaceutical industry has seen significant growth during the COVID-19 pandemic. These events not only affect business confidence, but also lead to major changes in business trends. Therefore, while it is important to understand these effects, understanding them is still not enough for business market confidence due to the uncertainty and fragility of the global financial system. Models are being developed that can predict the stock market. The neural networks[4] which is originated from ML and DL algorithms, have became most useful tools in stock exchange, with the full prosperity to learn from past data and discover hidden patterns to create predictions. Machine learning, in particular, allows machines to learn from past data without explicit instructions, making it a versatile solution for electronic applications for diagnosis and treatment in areas such as retail marketing. Of these methods, time

series analysis is widely used in stock market forecasting because it can handle time-related information. However, traditional models such as ARIMA[2] have limitations in addressing financial market dynamics. Popular techniques for business forecasting include K-Nearest Neighbors (KNN), Linear Regression (LR), Support Vector Regressor (SVR), Decision Tree Regressor (DTR), and Long Distance Model (LSTM)[6][5] networks. These algorithms are designed to handle a various number of complex business data. LSTM is particularly good at capturing long-term trends in time series data, while KNN and other methods recognize the simplicity and efficiency of their regression function. This article aims to gain a deeper understanding of business forecasting learning by developing and analyzing the capabilities of five learning machines (KNN, LR, SVR, DTR, and LSTM). We will train and test this model using historical data from 12 companies that have experienced distress over 16 years (2005–2021) based on percent error (SMAPE), Rsquared (R^2), and root mean square error (RMSE). The goal is to identify the most reliable trading models that will provide investors with the tools to improve the complexity of financial markets.At the previous days Company stocks and stock market topics were discussed only by a little no. of literate people but now a days the scenario is quite opposite, A largenumber of people want to invest and want to know more about stock market and these have a great impact on price changing of stocks and fluctuation on stock price of registered companies.

About Stock Market

Stock Exchange

The stock market can affect GDP (gross domestic product) and is commonly used as a sentiment indicator. A measure of an economy's overall production of goods and services is called GDP. Economic sentiment fluctuates in tandem with changes in the stock market. Changes in emotion cause people's spending to fluctuate, which propels GDP growth. Conversely, the stock market can impact GDP in both good and negative ways. A percentage increase from one period to the next is typically used to express GDP. For instance, if the growth rate from quarter to quarter is 2 percent the economy grew by 2 percent annually during that quarter. It is crucial to keep in mind that consumption accounts for the majority of India's GDP.There are two major stock exchanges in India: the National Stock Exchange (NSE), which has about 1600 listed businesses, and the Bombay Stock Exchange (BSE)[3], which has about 5000 listed companies. The trading processes and functionality of the NSE and the BSE are comparable. Trading accounts and Demat are the primary means of trading in the stock market. While businesses benefit from an influx of investments into their endeavours, stock markets assist the general public in channelling and pooling their savings. The Indian stock market has revolutionised the country's investment landscape. Now a days the small capital investors are indulging themselves to the market of Equity in search of higher profits due to rising inflation, falling bank interest rates, and other factors.

New Product Launch

Analysis of how a new product affects the stock price of a company can only be framed in the context of various factors like the kind of product introduced, the size of the company, what the market expects and many others. In general,stock prices may vary before and after a product launch, owing to investor mood and market speculation.There is frequently an early spike in stock prices[9] when a business releases a new product, particularly in the technology sector. Investor excitement over the product's potential for success and its capacity to generate future revenue is the reason for this growth. For example, a new product launch may have a more noticeable positive impact on stock prices for smaller companies or those with lower revenues.

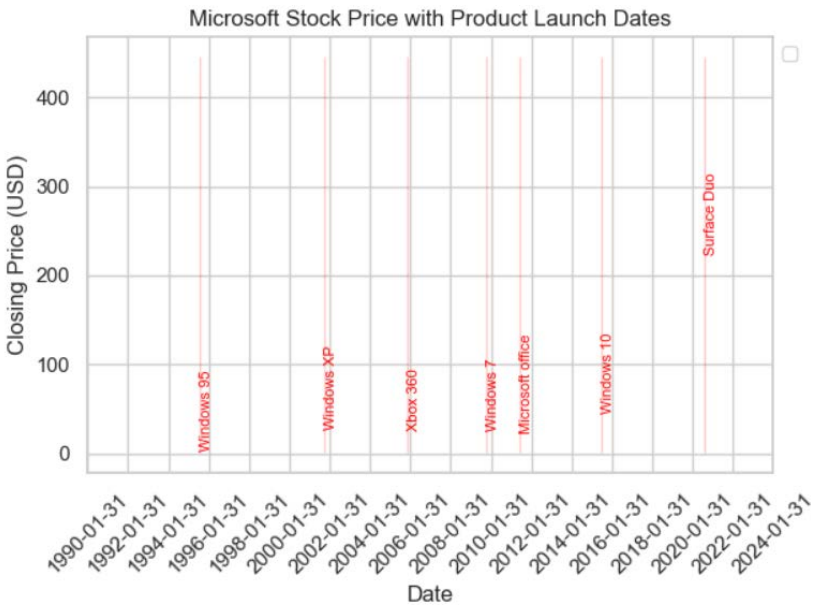

Fig. 1: Impact of launched products

This is probably due to the fact that these businesses frequently depend more on particular items for their overall profitability, and a good launch can greatly raise their market value and perception.On the other hand, established products from bigger companies may not capture thesame hype. In fact, studies have indicated that some high-revenue companies experience returns below zero in the period surrounding the release of aproduct. This might happen because investors have higher[5] hopes for such companies,if the new product fails to spark enthusiasm, or if there are doubts about performance or whetherthe product even gets off the ground, the stock price can fall as investors react to perceived disappointments.

Fig. 2: XBox Launching Impact

Stock Prediction Techniques Taxonomy

A several ML and DL techniques are used to predict the future trend and the stock price of companies.By improving day by day these techniques [2] gained popularity and have showing promising results in the field of stock analysis [3].

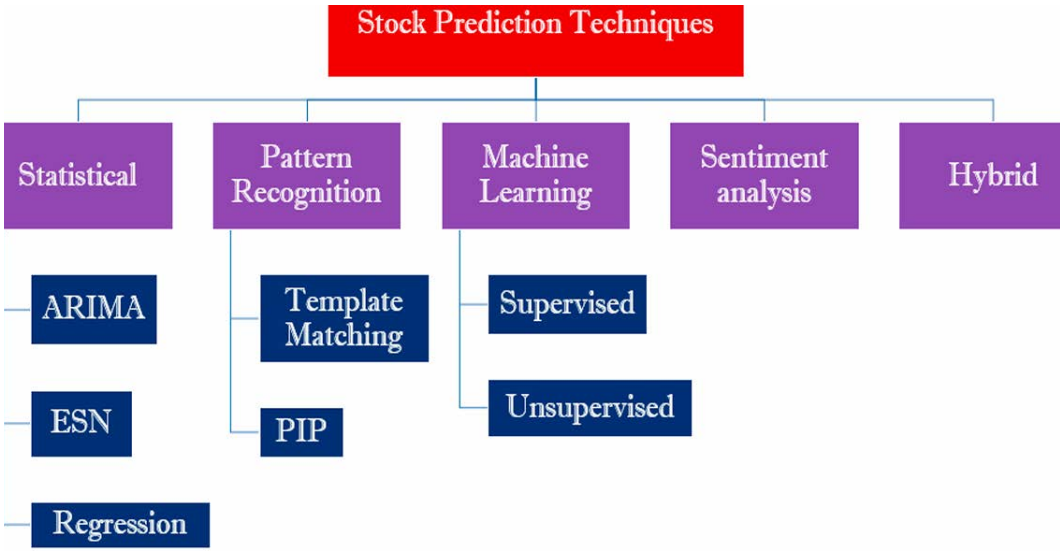

Fig. 3

Literature Review

The connection of introducing new products to the stock market price movement, as a focal point of financial science study has shown an invaluable hidden nature on how investors behave in some dexterity and why shareholders reply accordingly. A vast literature has documented the importance of new product announcements (NPAs) as potentially having a sizable effect on stock prices, and most often serve to contain investor sentiment regarding future profitability. Prior research has found that NPAs[2] generally have larger stock price reactions, especially in the presence of detailed disclosures about innovation. Example: Research by Jenny Chu et. Second, the personalized press (2024) suggests that there is an increase in market response over three days when innovation disclosure increases by one standard deviation. The implication being that investors find it highly relevant and strong with regards to predicting future sales-growth in the sense of a more complete set of details on firm's innovation capacities.It asked why these stock prices can change because there are a number of mechanisms at work here. The prime cause for this is investor sentiment and requirement of the hour. This in turn can increase shareholder demand driving up the prices especially if they are trading at a discount. At the same time, if an announcement is not materially innovative or perceived poorly by investors, it can create a lack of interest in investor sentiment and stock prices may again subsequently fall. The competitive landscape also largely influences this — businesses in less competitive markets that have NPAs may use the assets as a strategic advantage to create an additional layer of perceived value and movement for market response.New product launches typically come with a fair amount of enthusiasm — more demand for shares means higher prices. Nevertheless, if the market thinks that a product is disappointing or there are just too many offers from other participants then prices may be pushed down.A wide range of factors, including company-specific actions like New product launching and announcement of their gross profits as well as general market dynamics, affect how complex stock price swings[6] are. Although auto regressive integrated moving averages (ARIMA) and other traditional statistical techniques have been utilized extensively for time series forecasting, they frequently fail to capture the nonlinear patterns present in financial data. Machine learning techniques have therefore become strong substitutes. Large volumes of historical data can be processed using these techniques to find hidden links and patterns that conventional models might miss.Recent studiesprovide a detailed overview of the strengths and weaknesses of the different predictive models. For example,ML algorithms like artificial neural network and random forest, which establish themselves as not much depending on economic

theories, since,they can deal with nonlinear relations. On the other hand, DL models with convolutional neural networks (CNN) [4] and LSTM networks have shown their best performance in handling complex data types and capturing time dependencies, which is ideal for stock price forecasting.

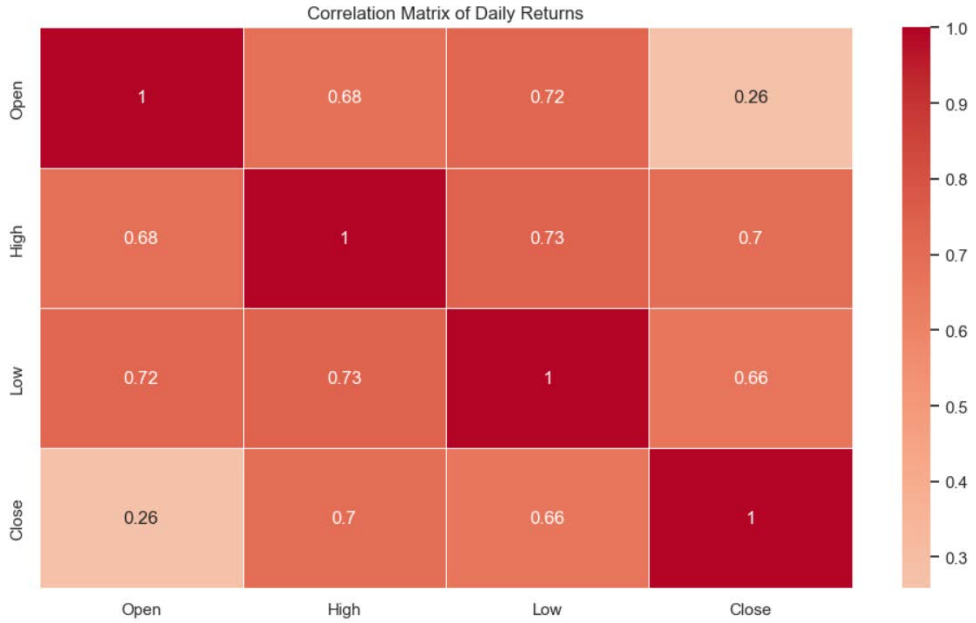

Fig. 4: Daily returns regarding the market

The Microsoft stock price data has been taken from MSFT (MICROSOFT CORPORATION) named ticker which is used to download the data set from Yahoo Finance with the time range of 1990-01-01 to 2025-02-02. Because during this period of time Microsoft has a large number of new product launches and improving their services each day and that helped me a lot to understand the changing of stock prices [4].We have to download the data set from the yfinance library of Python. Cause it's easy to fetch and upto-dated. The variation of price is very lean some of times so for that we have to focus each and every point of time and variation.For analyzing the stock price[3] fluctuation reasons and patterns we need real time data so for that it's very important to take a long time period data,[9] which is contained with every Product launching, Natural Disaster changing reasons.Most effective products which have a great impact on stock market, some of them are taken here which are :'Windows 95': '1995-08-24', 'Windows XP': '2001-10- 25', 'Xbox 360' :'2005-11-22', 'Windows 7': '2009-10-22', 'Microsoft office' : '2011-06-28', 'Windows 10': '2015-07-29', 'Surface Duo': '2020-09-10'.

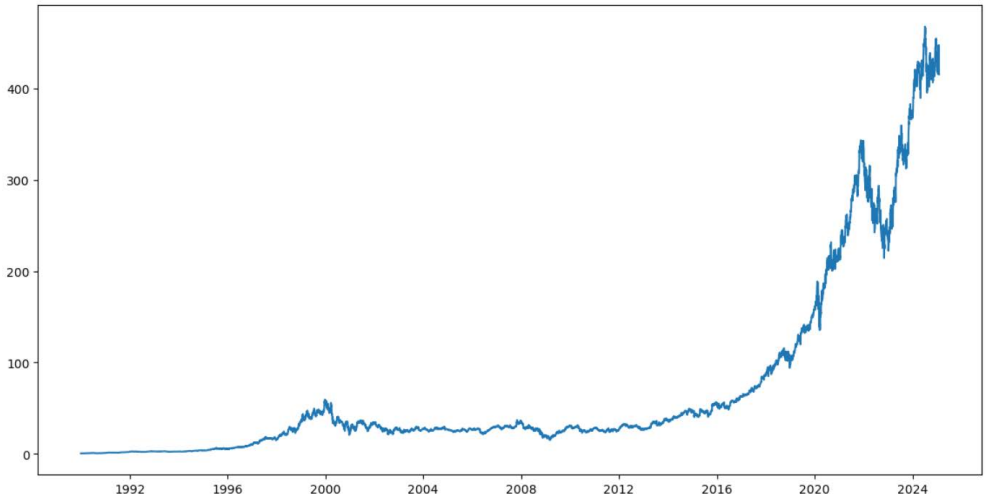

Fig. 5: Year wise variation

Methodology

For find out the stock price changing of Microsoft, During a new product launch by using the DL and ML algorithms like LSTM, SVM, NLP, Transformers, and many more algorithms like this. The most common approach toevaluate stock price reactions around product launches follows an event study methodology. Researchers[8] can determine abnormal returns—returns that differ from expected returns based on past performance or marketdeterminants—through this analysis. The event window should be several days before and after the product launch to capture the firm's market reaction.

Flactuation of Stock

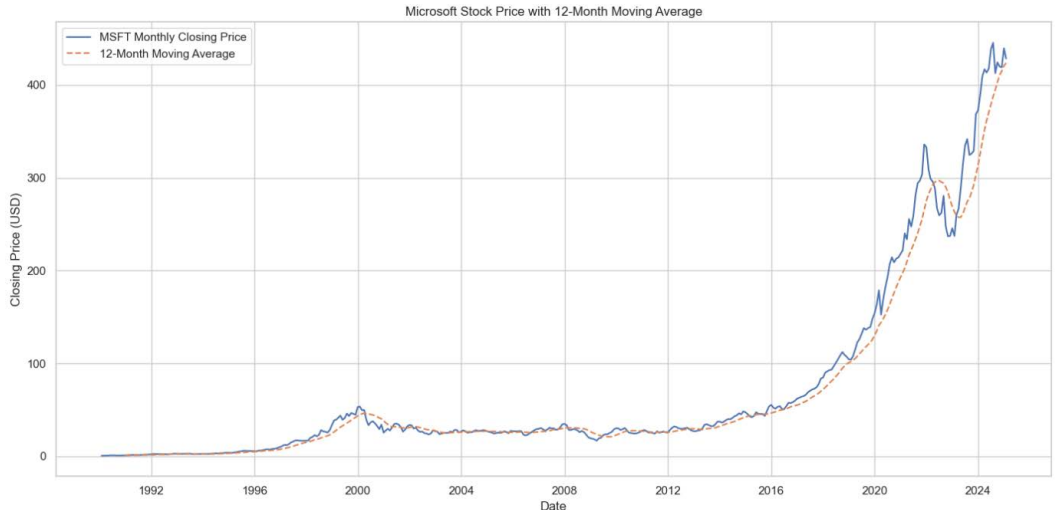

Fig. 6: Stock closing price over the years

In this graph[5] it is very easily explained that how much[12] the stock price of Microsoft has been evaluated through the couple of years, Among these years a multi number of service base products and service based softwares[8] have been launched and this variation only possible because of this circumstances.

Used Methods

A hybrid model has been prepared for finding out the best Accuracy Score[7][8] and a Lower Loss[8] function cause Stock Market is a affiliated market and Subject to market risk so for-that it can have a huge fluctuation by any time so for that none of those Neural network will be able to find out the accurate result Till now. 1) Basic Neural Network: A neural network which used to feed forward the weights and a Back propagation network for optimizing the whole[4] biases. Forward Pass:A forward feeding neural network with one hidden layer.

$$z^{(1)} = W^{(1)}x + b^{(1)}$$

where:

- $W^{(1)}$ is the weight matrix for the first layer.
- $b^{(1)}$ is the bias vector for the first layer.

An activation function f (e.g., ReLU, Sigmoid) is applied to introduce non-linearity:

$$a^{(1)} = f(z^{(1)})$$

Output Layer:

The second layer transforms the hidden layer activations [7]into the output:

$$z^{(2)} = W^{(2)}a^{(1)} + b^{(2)}$$

For regression (predicting a continuous change in stock price), the output y is typically left as a linear activation:

$$\hat{y} = z^{(2)}$$

For classification (e.g., predicting stock price increase/decrease), a softmax activation is used:

$$\hat{y}_i = \frac{ez_i^{(2)}}{\sum_j e^{z_j^{(2)}}}$$

Back Propagation:The updated weights and biases are used for gradient descent:

$$W \leftarrow W - n \frac{\partial L}{\partial W}$$

$$b \leftarrow b - n \frac{\partial L}{\partial b}$$

where the Learning Rate is n, and $\partial L/\partial W$ and $\partial L/\partial b$ are gradients computed during back propagation.

2) RNN and LSTM: RNNs and LSTMs[10] recognize that for input data that changes over time such as stock prices or event-driven data at time, changing over continuous time(t), the structure[2] and equations used reflect the relationship that these sequences havewith one another in predicting changes in the stock price given a new launch with an event-label close to (t)[9][10]. Hereare the concepts and equations:

RNN forward pass:

RNNs are basically programmed for handling sequential data by maintaining a hidden state ht, which acts as a memory of past computations. For a sequence of inputs $x_1, x_2, \ldots, x_T$, the RNN computes:

$$h_t = f(W_h h_{t-1} + W_x x_t + b_h)$$

where:

- h_t: Hidden state at time t.
- x_t: Input vector at time t (e.g., market sentiment, stock price history, product features).
- W_h, W_x: Weight matrices for the hidden state and input.
- b_h: Bias vector.

- *f*: Activation function, typically tanh or ReLU.
- The output y_t at each time step is computed as:

The output yt at each time step is computed as:

$$y_t = W_y h_t + b_y$$

For regression tasks (predicting stock price changes), y_t might represent a continuous value. For classification tasks (predicting price increase or decrease), a softmax activation can be applied to y_t.

LSTM Gate Equations

1. Forget Gate: Decides which parts of the cell state to forget:

$$f_t = \sigma\left(W_f x_t + U_f h_{t-1} + b_f\right)$$

2. Input Gate: Decides[10] which new information to add to the cell state:forget:

$$i_t = \sigma\left(W_i x_t + U_i h_{t-1} + b_i\right)$$

$$\acute{C}t = \tanh(W_c x_t + U_c ht - 1 + b_c)$$

3. Update Cell State:forget:

$$C_t = f_t \odot C_{t-1} + i_t \odot \acute{C}_t$$

4. Output Gate: Decides what information to pass to the next hidden state:

$$o_t = \sigma\left(W_o x_t + U_o h_{t-1} + b_o\right)$$

$$h_t = o_t \odot \tanh(C_t)$$

where:

- σ : Sigmoid activation function.
- $\odot$: Element-wise multiplication.
- W_x, U_x, b_x: Weight matrices and bias vectors for the gates.

3) Gradient Descent: Gradient Descent (or its variants) for optimizing the model used for stock price prediction[9]. In practice, modern frameworks like TensorFlow/Keras implement a various number of Gradient Descent algorithms, such as SGD, RMSProp, ADAM or Adagrad, as optimizers. Let the input features for the model be represented as:

$$x = [x_1, x_2, .., x_n]$$

These features can include historical stock prices, sentiment analysis, product features, and other relevant data. The model output (predicted stock price change) is given by:

$$\hat{y} = f(x; \theta)$$

where f is the model function (e.g., a neural network), and θ represents the model parameters (weights and biases).

Comparison Between Product Launching Before and After Price

1) Stock performance: The changing of price variation due to the new product launched is large cause every time when a new product or service[7] is introduced to market [4] then it would have a impact on Human world then investors[12] check for the feedback's and set their mind for invest or withdraw their money from it and that's how the multinational companies decide that which kind of product or service[6] should be introduced and they could be more beneficial by it.forget:

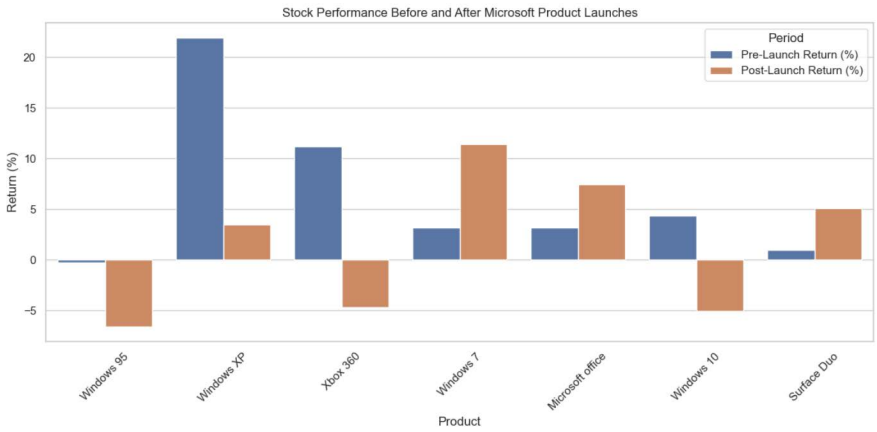

Fig. 7: Impact of launched products

2) Volatility of Stocks: A volatile market is a real cause for the hype of stock market and that's where a stock broker uses his knowledge and the recent days which AI(Artificial Intelligence) and API are introduced for easiness of understanding the investing market[7]. The root causes of market swings are intricate and stem from various economic, geopolitical[12], and psychological elements. Economic data like inflation rates, changes in interest rates, and job numbers affect how markets view things and how investors act. Take, for instance when central banks make a surprise move with interest rates. This can lead to quick shifts in stock prices[12] as investors rethink what they expect from the economy going forward. Also, world events such as wars or elections can bring uncertainty to the market[9]. This means investors respond to fresh news.

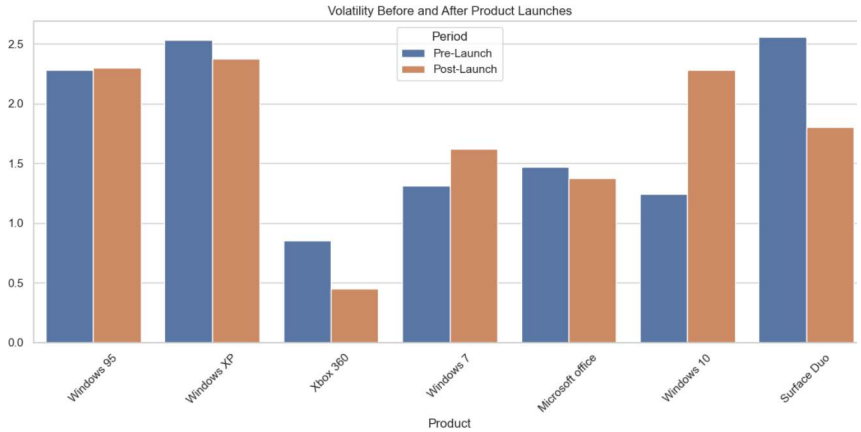

Fig. 8: Market Volatility

Conclusion

In brief, The objective of the model is to find out that which kind of new product is launched by a company and when, that's how it impacts on the Global market and from this the previous stock holders can have a guess that how market will react on it and also could be beneficial for the company to understand that what kind of product or service should they launch so from there they will be able to fulfill customer needs and By this they could be in a profitable place.

Future Scope

There are several exciting pathways for future work on predicting the changesin stock price given a new product launch with deep learning and machine learning,One potentially productive line of work hasto do with making models more interpretable, allowing stakeholders to make sense of what influences predictions. Interpretability—SHAP (SHapley Additive exPlanations) or LIME (Local Interpretable Modelagnostic Explanations) are examples ofadvanced explainability techniques that can be used to see how various product launch characteristics impact stock price movements.Other avenueis multi-modal data. The price of stock is affected by various things including players in themarket exam, product-specific features, macroeconomic conditions, and certain industry trends. To yield more comprehensive and accuratemodels, researchers could combine textual data in the form of news articles, social media sentiment analysis, and visual data such as product launch presentations or advertisements. Natural language processing (NLP) technologies — particularly transformer-based models such as BERT and GPT —may be particularly useful for analysing text-based information. More research could be done on advanced architectures notice Transformers adjusted to time arrangements, Temporal Convolutional Networks (TCNs, and LSTM) organize. Combine those models with reinforcement learning and systems may thenbe able to optimise trading strategies around the predictions. The Neural Network techniques have a great impact on previous data and recent data.Domain adaptation and transfer learning methods may also beexplored by the researchers. Knowledge acquired from other similar domains can be useful to build stock price prediction modelsof one industry or region. Transfer learning could enable researchers to leverage knowledge gained from one set ofproducts or markets to another, lessening the burden of needing to retrain and acquire large datasets. Last but not least, fairness and ethical issues within prediction models are still crucial. This summarizes research opportunities based on our proposedclassification. Train data is unfair may lead to predictions that over-report/under-report particular companiesor products. Future studies mayfocus on achieving and keeping high accuracy and fair and unbiased predictions.

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Early Warning Systems (EWS) for Student Dropout Prediction in The Education/Higher Educational Sector

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Abstract

School dropout remains a significant challenge in education and higher education. Various factors contribute to dropout rates, impacting individuals, institutions, and society. Early Warning Systems (EWS) have emerged as a promising solution to predict and prevent student dropouts using data analytics and technology. This paper provides an overview of existing research, methodologies, and challenges associated with EWS, emphasizing their role in educational sustainability and equity.

Introduction

Student dropout is a critical concern in education and higher education (Kumar et al., 2017). It disrupts learning, incurs financial losses for institutions, and hampers efforts toward inclusive education. Early Warning Systems (EWS) leverage data analytics to predict at-risk students and enable timely interventions (Nouri, 2019). This paper explores the significance of EWS, its methodologies, and associated challenges to enhance educational outcomes.

Importance of Student Dropout Prediction

Dropout rates are influenced by academic, emotional, social, and economic factors. Identifying at-risk students early allows institutions to provide support, significantly improving academic success rates (Del Bonifro et al., 2020). Dropout prevention has long-term societal benefits, including workforce development and economic stability (Dorn et al., 2021). Institutions increasingly adopt EWS to analyze academic records, personal data, and engagement metrics, applying targeted support strategies such as mentoring and counseling.

Challenges in Implementing EWS

Despite its advantages, implementing EWS presents several challenges (Zhang et al., 2023):

- Data Accuracy & Availability: Reliable data is essential for accurate predictions. Missing or inconsistent data can undermine system effectiveness.
- Privacy & Ethical Concerns: Institutions must ensure student data is collected, stored, and used ethically, complying with regulations.
- Bias in Machine Learning Models: EWS algorithms may inadvertently reinforce biases present in historical data, leading to unfair categorization of students (Akçapınar, 2019).
- Intervention Strategies: Effective response mechanisms are crucial. Institutions must allocate appropriate resources such as counselors, academic advisors, and social support services (Bañeres et al., 2020).

Methodologies and Data Sources

EWS utilizes a combination of statistical analysis, machine learning, and predictive modeling to identify at-risk students. The following key data sources enhance predictive accuracy:

- Academic Performance: Grades, course completion rates, and standardized test scores.
- Socioeconomic Factors: Parental education level, financial background, and first-generation college status.
- Engagement Metrics: Attendance records, participation in extracurricular activities, and digital classroom interactions.
- Behavioral Indicators: Disciplinary records, changes in study habits, and course withdrawal patterns.

Research Methodology

This study employs a structured literature review, ensuring credibility and relevance by:

1. Data Collection: Identifying research papers, books, and reports from academic databases using specific keywords.
2. Screening & Inclusion Criteria: Selecting peer-reviewed sources with high relevance and credibility.
3. Data Analysis: Identifying recurring themes, emerging research areas, and key EWS challenges.
4. Critical Evaluation: Assessing research quality, biases, and limitations to provide a balanced perspective.
5. Synthesis of Findings: Integrating insights into a comprehensive analysis of EWS methodologies and their impact on student retention.

Conclusion and Future Directions

EWS is an evolving field with immense potential to transform education by predicting and mitigating student dropout risks. Future research should focus on:

- Enhancing predictive accuracy through advanced machine learning techniques.
- Integrating EWS with learning management systems for real-time monitoring.
- Addressing ethical concerns to ensure fair and responsible use of student data.

By continuously improving these systems, institutions can provide equitable educational opportunities, reducing dropout rates and fostering long-term student success.

HR Digitalisation Influences on Organizational Performance in SMEs. : A Study Referencing the Western Province of Sri Lanka

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Abstract

This research analyzed the effects of HR digitalization on organizational performance among Small and Medium Enterprises (SMEs) operating in Sri Lanka's Western Province. It examined the essential difference between traditional HR practices and digital transformation in Sri Lankan SMEs to understand how digital HR solutions affect operational efficiency, decision-making processes, and organizational performance. The research applied a quantitative approach to collect structured questionnaires from 384 Western Province SMEs. Research investigated four essential HR digitalization features, including recruitment systems, employee management systems, data management systems, and verification systems. The analysis involved SPSS version 26 to test hypotheses examining the relationship between HR digitalization and business performance. The research outcomes showed clear positive associations between HR digitalization measures in SME businesses and their performance outcomes. The introduction of digital HR platforms yielded significant operational enhancements by implementing automated procedures that cut manual labour by 38% and lowered documentation mistakes by 45% According to study findings, digital recruitment processes increased talent recruitment quality by 28%, while integrated HR management systems sped up decision-making by 35%. Cost assessments revealed that organizations achieved an average 25% decrease in operational expenditures after implementing digital solutions. Despite positive assessments, the research discovered various obstacles in adopting digital HR solutions, such as financial limitations, skills shortages, and staff reluctance toward change initiatives. The study delivers essential knowledge that policymakers and small and medium enterprise owners need to create digital human resource transformation strategies. The research findings add to existing knowledge on digital human resource transformation in developing economies while suggesting practical guidance for small and medium enterprises that want better organizational performance through HR technology. Future studies about digital transformation in Sri Lankan SMEs can leverage this research to build fundamental knowledge while offering guidelines for implementing successful HR digitalization strategies.

The Need of Digital Healthcare Management Interference for the Public Healthcare System to Enhance the Doctor's Performance in Sri Lanka

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Abstract

Healthcare is quite an important phenomenon for sustainability in any country. As the national will keep the entire citizens, it is a must to maintain a strong and performing healthcare system especially, in a country like Sri Lanka. The Sri Lankan healthcare system is playing a vital role in the healthcare system. The existing economy, population growth, the citizens' trust in public healthcare and the increase of tourist visits have pressurized the public healthcare system. Findings have indicated nearly 95% of inpatient and 50% of outpatient care will be facilitated by the public healthcare system. Doctor's exodus has been booming for the past years and it has been identified as a serious problem for the public healthcare system in Sri Lanka. As the main decision maker of the healthcare of the citizens, the professional vacuum has a crucial impact on the healthcare industry. At the same time, existing doctors are exhausted by the work pressure. But keep the national healthcare system on standby, the performance gap should be filled. Digital Healthcare Management has been recognized as a prominent solution to manage this kind of situation. A lot of prior findings have asserted the positive effectiveness of Digital Healthcare Management on the country's healthcare system Electronic Health Records (EHR) and KIOSK have been identified as the most popular digital healthcare management tools for the world healthcare context. The quantitative method was used, followed by the deductive approach and a survey process was deployed using a questionnaire for 200 randomly selected doctors to gather necessary data for the analysis. Using the SPSS software tool, a comprehensive analysis was conducted and the analysis indicated a significant relationship between Digital Healthcare Management has a positive direct relationship with doctors' performance. Same time it has been found that both EHR and KIOSK both have contributed in maximizing the doctor's performance. The findings were delivered by identifying a paramount need in the Sri Lankan healthcare sector and necessary directions and guidelines were delivered to the Ministry of Health Sri Lanka, policy makers and doctors to make the performing healthcare system within the Sri Lankan healthcare system.

BUSINESS MANAGEMENT

Bridging the Gap by Leveraging Emerging Technologies for Sustainable Development in the Global South

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Abstract

The Global South faces significant challenges in achieving sustainable development, including limited access to resources, infrastructure, and technology. However, the rapid growth of emerging technologies such as artificial intelligence, blockchain, and the Internet of Things (IoT) present an opportunity to bridge this gap. This research aims to explore the potential of emerging technologies to support sustainable development in the Global South, with a focus on improving access to healthcare, education, and economic opportunities. A mixed-methods approach is employed, combining a comprehensive literature review, expert interviews, and case studies of successful implementations. The results highlight the potential of emerging technologies to enhance sustainable development outcomes, but also identify significant challenges related to infrastructure, digital literacy, and regulatory frameworks. The study concludes by outlining a framework for leveraging emerging technologies to support sustainable development in the Global South, and identifies areas for further research and policy development.

Keywords

Sustainable development, technologies, Artificial intelligence (AI), Blockchain
Internet of Things (IoT), Healthcare, Education, Economic opportunities, Digital literacy, Infrastructure, , Policy development

Leveraging Sustainable Logistics in the Organic Food Industry in Sri Lanka: Bridging Gaps for Sustainable Development

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Abstract

The organic food industries in Sri Lanka have been expanding with increasing consumption trends towards a healthy and green lifestyle. The agricultural sector, which includes the organic food industry, holds a substantial proportion of the contribution to economic growth in Sri Lanka in recent years. The exportation of organic foods has taken attention concerning the current market. For the success of the organic food industries, the best logistics management practices become more crucial. The study aims to explore the best logistics management practiced in the organic food industries and to identify the challenges related to logistics management in organic Food Industries in Sri Lanka. This study is carried out as a literature survey and outcomes of previous studies from different research were considered. Further, the secondary data derived from a previous study conducted interviews with 5 well recognized organic food producing companies in the Colombo district out of the target population to learn logistics management in organic Food Industries in Sri Lanka. This study derived the outcome through the thematic analysis of collected data from literature survey. As logistics of the organic food sectors highly impact on the success of the marketing, this study identified that the three main components of logistics such as packaging, transportation and storage. However, the study reveals that Packaging type and Packing materials impact on the quality of the organic food when it reaches the consumer. Further, it finds out that the organic food industries mainly focusing on these three logistics components as they highly impact on the shelf life of the product. In addition, the logistics management practices are developed mainly considering the climatic factors as these factors affect the quality of the products. The loading and unloading for the transportation and storage purpose challenge the quality of the organic fruits and vegetables. It affects the freshness of the organic fruits and vegetable. The specific handling, packaging and storage conditions through to the period of transport are highly concerned to ensure the high quality product when it reaches the consumer. The contamination and influence of external vibration also impact the quality of these organic fruits and vegetable due to the perishable nature. The study finds out that organic food sectors are always trying to ensure the naturalness or freshness of the organic products as they are when they reach the consumer. Further, study ensured that transport with the refrigerated facilities increases the shelf life and minimizes the deterioration and damages. Efforts to reduce losses in the logistic chains for organic products can be made by focusing on these challenges and developing strategies based on production and transformation standards and end-product quality.

Keywords

Quality of Foods, Organic Foods, Logistics management Practices, Sustainability, External factors

Exploring the Role of Sustainable Training Programs in Enhancing Call Center Performance within the Financial Sector in Sri Lanka

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Introduction

Call centers are now crucial to the financial services sector's ability to manage client connections, respond to their questions, and offer assistance. Businesses are investing in training initiatives to boost call center agents' effectiveness in response to the growing demand for superior customer service. The success of these training programs is essential since client satisfaction was directly impacted by the caliber of services rendered. loyalty as well as general business results. For a financial organization, accuracy and client trust are crucial. Call center representatives must possess the information, abilities, and resources necessary to meet performance goals.

Training programs are intended to improve agents' problem-solving, communication, and product expertise as well as their familiarity with compliance and regulatory requirements—all of which are critical in a workplace involving money. However, a more thorough investigation is necessary to determine the true effect of these training initiatives on call center performance. According to research, systematic training can result in better first call resolution rates, shorter call handling times, and higher call quality.

The purpose of this study is to investigate the relationship between sequential training and how it affects call center agents' performance in a financial services setting in Sri Lanka. Financial services is one of the industries that has been paying more attention to sustainable training programs, which emphasize long-term development and socially and environmentally responsible practices. This study will advance knowledge of how particular training interventions impact customer interactions, productivity, and overall business outcomes at a finance company's call center by analyzing a variety of performance metrics and staff feedback.

Literature Review

The purpose of this research is to reduce average hold time, reduce average waiting time, maintain zero customer complaints by enhancing quality of the calls. Sustainable training programs go beyond conventional methods by emphasizing the integration of socially, economically, and environmentally responsible behaviors in addition to skill development. According to McWilliams and Siegel (2001), these initiatives are intended to promote long-term employee development and guarantee that corporate and individual objectives are fulfilled without having an adverse effect on the environment or society. Promoting diversity and inclusion, fostering a culture of continuous improvement, and using digital learning tools to cut down on travel and paper waste are some examples of sustainable training.

Sustainable training programs for call centers could include energy-efficient procedures, virtual learning resources, and a focus on the emotional and physical wellness of staff members. These factors are crucial, especially in high-stress settings like contact centers, where employee attrition and burnout are common (Kuo et al., 2019).

The effect of training on call center performance has been the subject of numerous investigations. Enhancing customer happiness, cutting down on call times, and improving

service quality all depend on training programs that emphasize technical knowledge, problem-solving capabilities, and customer service talents (Kim & Lee, 2018). Additionally, call centers that make continuous development investments are probably going to witness higher staff engagement, fewer employee attrition, and better employee performance (Saks, 2002).

Numerous studies have examined the impact of training on call center performance. Training programs that prioritize technical knowledge, problem-solving skills, and customer service abilities are essential for increasing customer satisfaction, reducing contact times, and enhancing service quality (Kim & Lee, 2018). Furthermore, call centers that invest in ongoing development are likely to see improvements in employee performance, lower employee attrition, and increased staff engagement (Saks, 2002).

Training programs can also concentrate on risk management, financial products, and regulatory expertise in the financial industry, where precision and compliance are crucial. In a highly regulated sector, these specific abilities are crucial for agents managing intricate client inquiries (Boyd & Lynch, 2020). The capacity to incorporate sustainability into these training methods improves long-term outcomes by guaranteeing that workers are consistently growing in ways that complement organizational and societal objectives.

Employee retention and satisfaction are directly related to sustainable training initiatives. According to a 2015 study by Lievens and De Paepe, workers who receive training that fosters their professional and personal growth typically report better levels of engagement and job satisfaction. In call centers, where high turnover and burnout are common problems, this is especially crucial (Barker & Härtel, 2005).

Financial organizations can lessen their environmental effect by implementing online learning modules, webinars, and virtual coaching as the use of digital platforms in training increases. Virtual training solutions offer scalability, flexibility, and cost-effectiveness in addition to lowering travel-related carbon footprints, per Gartner's research from 2021.

Additionally, incorporating sustainable practices into training can assist businesses in achieving more general environmental objectives. For instance, banks and other financial organizations should include sustainability in their training materials to make sure staff members know how to offer environmentally friendly solutions to clients and make ethical financial product choices (Sullivan & Ellram, 2019).

Determining the return on investment (ROI) of sustainable training initiatives requires evaluating their efficacy. Call center success is still largely determined by traditional criteria like customer satisfaction ratings and call resolution times. To evaluate the effect of sustainable training, more metrics could be required. Measures of employee engagement, retention, and general well-being may be among them (Chung & Park, 2017).

According to research by Han & Lee (2019), employees who participate in sustainable training programs that help them develop a sense of purpose and environmental responsibility may feel more satisfied at work, which will improve performance. Customers, especially those who value ethical and sustainable practices, may become more brand loyal if sustainability is included into company culture and training.

Methodology

The purpose of this study is to examine impact of sustainable training programs on the performance of the call center agents in a finance company. To achieve this mix method

approach been applied combining both qualitative and quantitative research methods to provide a comprehensive understanding of how training influences various aspects of call center performance.

Research Design:
This research utilizes a comparative, longitudinal, comparing call center performance before and after continues training programs with regards to the products and call etiquettes. The longitudinal approach will allow for the assessment of performance trends over time, providing insight into both immediate and long term impact of the training.

Sample selection:
50 call center agents who are in inbound unit attached to a finance company were selected for this research.

The same sample group has been taken into performance evaluations before conducting trainings and after conducting trainings.

Additionally, call center supervisor feedback and trainers feedback also collected for the final decision. Both supervisor and trainers count of 10 participants were gathered for the comments.

Data Collection methods:

Quantity Data
The primary quantitative data collected through call center system.

1. Average call handling time – measures the time that agent spends on a customer call. Lower AHT is typically associated with greater efficiency.
2. Average call waiting time in call queue – Normally in a call center a threshold time is 20 seconds. The call waiting time before connecting to an agent.
3. Average call hold time – After answering a call while agent checking details the customer put on hold. Maintaining a lower hold time is great.
4. First call resolution – tracks the percentage of customer issues resolved in first call. Higher FCR is a critical measure of call centre effectiveness and customer satisfaction.
5. Employee productivity – Number of calls handled per shift.
6. Call quality index rating – agent's call evaluated by supervisors.

Qualitative Data
Interviews conducted through sample group and explored.

1. Agent's perception on training.
2. Challenges facing in applying training in real situations.
3. Suggestions for the improvements.

Additionally, observational studies may be conducted during live call center operations to observe agent behaviours post training and to understand how the training impacts customer interactions. Apart from that live calls audits calls spy been conducted

Data Analysis

Descriptive statistics – Performance data has been summarized.

Regression analysis – To access relationship between training and performance controlling for factors such and prior experience and call center work load.
Thematic analysis will be used to examine qualitative data in order to find recurring themes, patterns, and insights about the training program's efficacy and influence. This will make it easier to comprehend how the agent views the impact of the training on their performance and interactions with customers.

Evaluations and Results

After completing consecutive training programs, the quantitative data, including average call handling time, average call waiting time in queue, and average call hold time, decreased as compared to the period during which no training sessions were held. Additionally, following training sessions, inbound agents' productivity, call quality index rating, and first call resolution rate all saw sharp increases.

Agents who took part in the interviews felt more competent in their positions, especially when dealing with difficult customer complaints, according to the qualitative data gathered from the interviews. Numerous agents stated that the training enhanced their comprehension of the business's financial offerings and legal obligations, which gave them greater confidence in their ability to successfully handle client concerns. A number of agents reported that the training's focus on communication techniques like empathy and active listening were especially helpful in raising client satisfaction.

To better prepare them for the range of customer concerns they see on a daily basis, some agents stated that the training could have included more real-life scenarios and hands-on activities (role plays). Agents indicated a desire for greater practical situational practice, even if they valued academic understanding.

Discussion

One of the most important findings is that, following training, each agent's performance significantly improved. The call center conducts monthly evaluations and pays incentives for successful completion. Following the training sessions, the agents' incentive pay increased significantly in comparison to previous months.

Limitations and challenges

The in-depth knowledge gleaned from this one case study can nonetheless offer significant lessons for comparable financial firms, even though the study might not permit wide generalizations. Other businesses thinking about implementing sustainable training programs in their call centers should use the findings as a benchmark. However, without additional research, care should be taken when trying to immediately extend these findings to other circumstances. Notwithstanding the drawbacks of concentrating on a single business, the study's conclusions provide a number of useful suggestions that may be implemented in the particular setting of the company under review and possibly modified for use with other financial institutions that share comparable traits. Among these suggestions are: Integration of Sustainability into Training Program Design

Financial institutions ought to think about incorporating sustainable practices into their training initiatives in light of the findings. Using digital learning platforms to cut down on paper and travel could be one way to do this, which would save money and lessen the impact on the environment.

fostering long-term skill development by placing more emphasis on adaptation, ongoing learning, and employee well-being than on immediate performance improvements.

aligning employee behaviors with the organization's overarching sustainability goals by incorporating sustainability-related content into training programs (such as eco-friendly financial goods or energy-saving techniques).

Conclusion

This study offers important insights into how sustainable training programs might affect call center performance, even while its emphasis on a single financial organization restricts the capacity to extrapolate the findings to the larger financial sector. Financial institutions can develop a more effective and sustainable staff by emphasizing employee involvement, incorporating sustainability into training design, and regularly assessing program efficacy. Other businesses looking to establish or enhance long-term training initiatives in their call centers might use the useful suggestions offered as a reference.

These suggestions would be validated and improved with additional study involving several institutions or businesses, enabling a more thorough comprehension of how sustainable training may be expanded and tailored to diverse organizational situations.

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Implementation of E-Procurement practices for Procurement in Higher Educational Institutes in Sri Lanka

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Introduction

Electronic procurement consists of the processes such as transactional requisition, online authorizing, e-ordering, e-tendering and e-payment for goods or services procured through technological approaches in order to improve the performance of procurement. Hence, the traditionally procurement has some drawbacks especially inefficiencies, low transparency and low service quality as well as weak oversight roles, much delays, poor linkages between procurement and expenditures, and improper record management. The management of procurement in public universities stumbles up on the procurement operations due to the improper direction, poor coordination, less competition, much wastages and high levels of corruptions. The regulatory and policy framework on the procurement with lengthy manual procedures and strict policies was identified as the main barriers in the procurement management. Further, Previous studies recommended in switching into an e-procurement system to overcome these barriers.

Objectives of the study

- To evaluate critical success factors for effective e-procurement practices in Higher Educational Institutes (HEIs) in Sri Lanka.
- To evaluate the e-procurement practices followed in HEIs in Sri Lanka
- To ascertain the main factors affecting the implementation of e-procurement practices
- To find out the constraints in HEIs in Sri Lanka on implementation of e-procurement practices
- To establish strategies to improve e-procurement practices in HEIs in Sri Lanka

Methodology

The study was conducted by collecting the data through the structured questionnaire survey distributed via online among the professionals dealing with the procurement in HEIs in Sri Lanka. Further, the survey was conducted separately with the suppliers. Pooled and screened data were analyzed using SPSS Statistics 20.

Discussion and Summation on the research findings

The response rate is approximately 70% of the sample selected for the studies. However, it is deemed to be better enough for the representing the population.

Socio-demographic information of the targeted population and the entity

The majority of the respondents including the internal professionals and the suppliers are male. Majority of the internal stakeholders possess postgraduate qualifications and all suppliers are young, holding Bachelor's Degree. The most HEIs are dealing the procurement with junior level and majority of the procurement managers in supplier category are in middle management level.The system of the procurement sections in both internal and external categories are having centralized system up to certain extent. The study

Implementation of E- Procurement

reveals that the HEIs initiated the e- procurement practices comprising e-requisitioning, e-tendering, e- sourcing, e-approval, e-invoicing and e-payment up to certain extent by gradually adopting to the online mode. However, the descriptive analysis indicated these e-procurement practices in HEIs had the mean value is less than three. It clearly reveals that the implementation of e-procurement is poor in Sri Lankan HEIs as the output of the analysis shows that the each process of e-procurement falls between 1.7– 2.8. It observed that the initiation of e-procurement process has been already established at least with the one practices of procurement management at the lower level.

The findings of the descriptive analysis illustrated the model in the form of equation is $Y= 0.286\ X_1+0.286X_2+0.571\ X_3+0.286X4+ 0.286X_5+ 0.143X_6+ 0.143X_7+ \Sigma$

X_1 E-Requisitioning
X_2 E-Tendering
X_3 E-Sourcing
X_4 E-Approval
X_5 E-Ordering
X_6 E-Invoicing
X_7 E-Payment
Σ - Error

E-Procurement practices and Factors

The study found that several external and internal factors affect the outcomes associated with the e-procurement practices such as cost, quality, timeliness, reliability and security. The identified factors are government aspects, Technological aspects and organizational aspects as the mean of the each category was above 3 indicating that the level of effect is moderate level. The analysis indicates that the costs for implementation, costs for training required for staff and lack of resources significantly affect the performance of the E-Procurement.

All steps of e- procurement have not been fully adopted due to the identified barriers which significantly impact on the adoption of e-procurement. However, the survey explored that e-tendering scored the highest mean value among the other processes and are positively associated with the procurement outcomes.

Government Aspects

The study found that the government factors significantly impact on electronic procurement performance as the Pearson correlation value is 0.394 and identified as significant at 0.05 confidence level.

Organisational Factors

The present study found out that the organizational factors such as Policies and procedures of the institute, Organizational Readiness for Capacity development, Professional development, Performance assessment system, human resources management, Decision making ability of the Procurement and Technical Evaluation Committee, authorization, stakeholder readiness for changes etc. Significantly impact on the web based government procurement management in the procurement entities and influence the e-procurement process in the perception of the respondents. However, the policies and regulations of the institutes affect the e-procurement implementation. About 55% of the respondents agreed that the aforesaid factors affect the procurement practices.

Technological Aspects

The study is focused on ascertaining of the correlation between the technological factors including IT infrastructure facilities and the e-procurement performance, and revealed that there is a significant correlation between the technological aspects and the e-procurement practices at 0.01 level and the value is 0.966.

E-Procurement practices and benefits

E-Procurement & Quality

It revealed that the e-procurement performance in terms of quality is significantly associated with the e-procurement practices performed by the procurement entities. The output of the analysis for correlation between the e-procurement performance and the quality was 0.377 and significance at 0.05 confidential level. It is obvious that the quality of the performance associated with the practices of e-procurement.

E-Procurement & Reliability

This study pointed out that the reliability of the performance is positively associated with the e-procurement practices as the results of the analysis indicates the Pearson correlation value as 0.462 and significance at 0.01 level. The reliability of the e-procurement performance mostly shows positive association with the e-procurement performance achieved through e-sourcing, e-tendering, e-invoicing plus e-payment.

E Procurement & Timeliness

It is emphasized that the expected lead time is significantly less than the real lead time with a significant correlation (0.375 at 0.05 level) between the e-procurement practices and the required time frame.

E Procurement & Cost

It was proofed that the positive and significant correlation (around 75%) between the cost and e-procurement practices particularly throughout the process. However, this study found that there is no significance correlation between the cost reduction and the E-Procurement.

Challenges in implementation of e-procurement

The present study identified the following barriers in implementing e-procurement such as several procurement methods, lack of leadership skills of government authority, involvement of external granting agents, inadequate procurement performance, political influence, improper fund allocation, lack of enthusiasm in professional development, and adhering to the suppliers's conditions etc.

Supplier Interaction

It is revealed that the male younger suppliers prefer to go for the e-procurement practices and willing to change.

Reflection and recommendation

The model of the study of the current status of the procurement practices is partially adapted to the digitalized system for procurement. It is suggested to implement the staged implementation process from less complex process to more complex procedure incorporating the third party via outsourcing strategy to ensure the value of money for the implemention of the e-procurement system. In accordance with the self developed institutional policies and regulations in the direction of the cabinet approved e-Government Procurement guidelines issued by the National Procurement Commission, under the approval of governing authority of the particular HEIs.

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The Role of Female Labor Force Participation in Economic Growth: An Analysis of the Sri Lankan Female Labor Force Participation in the service sector

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Abstract

This study examines the impact of female labor force participation on economic growth in the service sector in Sri Lanka. Many economies are now focusing on inclusive labor policies, hence the need to establish the determinants of women's workforce participation and their macroeconomic contributions. In this regard, the study conducted time-series analysis to check the trends for the last three decades. Results prove that the increase in female employment in the service sector is closely linked with GDP growth, productivity, innovation and sustainability. In this study, the service sector refers to industries that provide intangible products. The service sector includes industries such as financial services, healthcare, education, hospitality and tourism, retail and e-commerce, IT and telecommunications and public services. The service sector is a major contributor to economic growth and employment, especially for female labor participation. The main determinants are education, wage equality and labor market policies that influence female labor force participation. It further emphasizes implications for sustainable economic development. Hence, policy recommendations go toward the enhancement of female employment opportunities within the service sector, which would contribute to long-term environmental, social and economic sustainability. The global labor force has shifted significantly in its structural composition with female participation lying at the heart of economic transformation. Females have made their presence felt in the workforce within the male-dominated service sectors of Sri Lanka driven by changing policies and technological changes influencing societal norms. The sustainable development goals highlight that for long-term stability, gender equality and economic empowerment are not only complementary but also integral parts. This study will be done to assess the level at which female participation in labor within the service industry influences economic growth, productivity and sustainable business. This research utilises a quantitative approach with secondary data from 1990 to 2021. The SPSS software is used to analyze the long-run and short-run relationships of female labor participation and economic growth. The key variables include labor market participation rates, GDP growth, wage distribution, educational attainment levels among female workers and sustainability indicators. It captures the effects of policy interventions and labor market dynamics on female employment trends and their contribution to sustainable economic development. The results have shown that increased female employment in service sectors aligns with economic growth. Higher participation rates contribute to increasing productivity, technological innovation, the general efficiency of labor and business models that are sustainable. Besides, countries with progressive labor policies have more sustainable growth patterns, with features such as flexible work arrangements, wage parity and corporate sustainability initiatives. It points out some of the main obstacles such as gender wage gaps, skill mismatches and socio-cultural constraints to integrating more women into the workforce, hence delaying the contribution of the service sector to sustainable economic growth. Therefore, this study highlights that gender-responsive

labor policies by policymakers would enable the economic potentials of women workers to be fully realized with sustainable development. It calls for business investment in education and vocational training, workplace inclusiveness, equal wages and corporate sustainability initiatives. The findings have implications for industry stakeholders on the need for structural reforms that promote better female workforce participation in the service sectors and contribute toward long-term economic and sustainability.

Keywords

Service Sector, Female labor force participation, Economic growth, Labor market policies, Innovation, Sustainability

IMPACT OF IMPLEMENTING GRIEVANCE REDRESS MECHANISM IN THE PUBLIC SECTOR OF SRILANKA

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Abstract

This study examines the effectiveness of Grievance Redress Mechanisms (GRMs in Sri Lanka's public sector, highlighting their role in improving service delivery and citizen-state relations. Using cross-sectional surveys and qualitative discussions, the research assesses GRM effectiveness in local government institutions. Findings reveal that well-implemented GRMs enhance public service delivery without compromising key factors like citizen participation, ease of access, response time, and state capability. However, challenges include the digital divide, resource constraints, and institutional disparities. Citizen awareness of GRMs remains inadequate, limiting engagement in grievance processes. The study contributes to public administration by recommending stronger digital platforms, continued physical contact centers, staff training, departmental integration, and GRM education. Performance monitoring and transparency in complaint handling are also emphasized. The evidence shows that properly implemented GRMs can enhance service delivery and public trust, but requires institutional support and resources, constant systemic review and enhancements, and strengthening public awareness. The study suggests well-coordination policy improvements and strategies, legislation, continuous evaluation, and leadership development that should be established to sustain GRMs in Sri Lanka's public sector.

Keywords

Public Service, Grievances, Grievance Redress Mechanism, Local Authorities, Citizen Engagement, Governance.

Introduction

Grievance Redress Mechanisms (GRMs) play a vital role in public administration by addressing citizen complaints and enhancing public governance. GRMs are structured and institutionalised systems designed to help individuals raise complaints and seek resolution for the services they are entitled to, improving citizen-state interactions and ensuring efficient, equitable, and transparent grievance resolution (Pande & Hossain, 2022).

In Sri Lanka, GRMs have been integrated into public sector governance, particularly within local government, to enhance service delivery (Francis, 2018). However, for GRMs to fulfil their potential, they must adopt citizen-centric designs and ensure transparency and resource efficiency in implementation (Hossain et al., 2023; Pande & Hossain, 2022). Despite their intended purpose, the functionality and empirical outcomes of GRMs require further analysis. This study aims to evaluate the effectiveness of GRMs in the Sri Lankan public sector, focusing on service delivery, customer satisfaction, and institutional accountability (Alahakoon & Jehan, 2020).

Problem Statement

Sri Lanka's GRMs face significant challenges that hinder their ability to meet objectives. Persistent issues such as political inertia, bureaucratic inefficiencies, weak oversight, poor responsiveness, and limited public awareness undermine their effectiveness (Perera,

2020; Gunawardane, 2018; Francis, 2018). Citizens in rural areas and those relying on non-governmental services often struggle to access GRM services due to technological, informational, and resource constraints (Ramesh, 2020).

Addressing these challenges is critical for promoting transparency, accountability, and equity in public service delivery (Fernando et al., 2024). Effective GRMs not only resolve complaints but also strengthen public trust in governance and contribute to sustainable development in diverse sociopolitical contexts (Rathnayaka & Fernando, 2020; Pande & Hossain, 2022).

Research Questions

What is the relationship between citizen engagement in grievance redressal and institutional capacity to implement GRM to enhance service delivery in Sri Lanka's public sector?

- How does the functionality of GRMs impact public service delivery?
- What role does institutional capacity play in the effective implementation of GRMs?
- How can GRMs enhance citizen satisfaction and trust in governance?

Literature Review

Grievance Redress Mechanisms are essential tools for promoting good governance by fostering transparency and accountability in public administration (Agarwal, 2013). GRMs have enhanced service delivery and strengthened state-citizen relationships globally, particularly in developing countries. They improve public trust by facilitating effective complaint handling (Ahmed, 2020).

In Sri Lanka, GRMs are integrated into governance reforms, particularly at the local government level. However, significant research gaps remain, with limited empirical studies on their performance and challenges, such as low public awareness, accessibility barriers, and varying institutional readiness (Perera, 2020). Additionally, little research explores citizen expectations or the role of technology in improving GRM functionality (Alahakoon & Jehan, 2020).

This study seeks to address these gaps by examining the impact of GRMs on service delivery, citizen satisfaction, and trust, narrowing the divide between theory and practice.

Methodology

A mixed-methods approach was employed to evaluate GRMs in Sri Lanka's public sector. Quantitative data were collected via structured questionnaires using a five-point Likert scale from 380 citizens and 75 public officials. Semi-structured interviews and focus group discussions provided qualitative insights into stakeholder experiences (Tzagkarakis & Kritas, 2022). Primary data sources included complaint registers, analytical reports, and local authority documents, while secondary sources comprised scholarly articles, journals, and policy documents.

The study focused on six local authorities in Sri Lanka's Northern and Eastern provinces, including Municipal Councils, Urban Councils, and Pradeshiya Sabhas, where GRMs are actively implemented. These grassroots institutions offered valuable insights into public service effectiveness and the symbolic power of GRMs in fostering change.

Key Findings

This study found that transparent, timely, and accessible Grievance Redress Mechanisms (GRMs) significantly enhance public service delivery by improving efficiency, fostering government accountability, and promoting positive citizen-government interactions. Effective complaint resolution strengthens public trust in the administration (Ahmed & Roy, 2020).

Public participation and state capacity, including resources, personnel, and institutional authority, are crucial in implementing the effectiveness of GRMs in service delivery and governance. However, several challenges impede GRM implementation and performance, including low citizen awareness (particularly in rural areas and marginalised communities), limited access, and institutional constraints such as inadequate resources and inconsistent implementation across local authorities.

Citizen awareness of GRMs varies based on education level, socioeconomic status, and geography. Urban residents are generally more informed about GRMs due to better access to information, while rural and marginalised populations remain less aware. Also, citizens have a limited understanding of the whole GRM process.

The state's capacity faces hurdles such as insufficient funding, limited staff training, bureaucratic inefficiencies, and weak coordination, which undermine GRMs' functionality and optimal performance despite efforts to strengthen state capacity.

It is, therefore, worth noting that despite the widely held impression that equates GRMs with accessibility and fairness, these systems have their downside, including time sensitivity and transparency.

Technological disparities and the lack of policy and legal frameworks further hinder GRMs' implementation for timely, fair, transparent, and efficient grievance resolution.

Despite these challenges, GRMs promote citizen participation, enhancing public accountability and responsiveness. Leveraging online platforms can improve GRM accessibility, but limited technological access in certain segments of the population remains a significant barrier. Addressing these systemic issues is crucial to optimising GRM functionality, strengthening trust in governance, and ensuring equitable service delivery (Gauri, 2013).

Recommendations

Policy Improvements:

- Strengthen legislative frameworks, ensure political commitment, and allocate adequate funding for GRM implementation, especially in rural areas.
- Develop consistent policies and ensure policy integration across local government levels aligns with broader governance frameworks for systematic improvements in public administration.

Strategies Development:

- Establishing clear metrics to measure improvement and standardised performance, including setting measurable objects, mechanisms for performance monitoring, continuous evaluation and learning.
- Establish a collaborative approach which involves multiple stakeholders in GRM development and implementation to ensure a more responsive and citizen-centric

system.

- Capacity Building
- Establish permanent roles, such as Public Relations Officers, to manage GRMs in resource-constrained rural settings.
- Train public officials to improve responsiveness and implementation, ensuring adequate fiscal and infrastructural support across local authorities.

Citizen Engagement

- Enhance public awareness of GRM procedures, focusing on marginalised populations and rural areas, to build trust and encourage utilisation.
- Ensure inclusive access by providing GRM to ensure accessibility for all populations and greater equity in public service delivery, such as multiple physical, online and offline access points and simplify them.

Digital Technology

- Expand digital platforms to streamline grievance reporting and response processes, leveraging robust information technology to increase accessibility and efficiency. Digital tools can also boost engagement among the younger, tech-savvy citizens.

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Assessing the Economic Potential of Agribusiness in Reviving Mullaitivu's Rural Economy

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Abstract

A study investigates the potential of agribusiness to revitalize the rural economy of Mullaitivu District, Sri Lanka, a region significantly impacted by the post-conflict economic downturn. The district's agricultural sector, crucial to its economy, suffers from underinvestment, outdated farming practices, and limited market access, leading to low yields, reduced incomes, and persistent poverty. Employing a mixed-methods approach, the study collected primary data through surveys and interviews with farmers, agribusiness entrepreneurs, and government officials. Secondary data was gathered from government reports and academic literature Key demographic and economic findings include: The largest respondent group (30.6%) was aged 45-55, followed by the 56-60 age group (16.7%). The sample comprised 47.2% female and 52.8% male respondents. Nearly all respondents had an education level below advanced level. Regarding employment, approximately 47% were engaged in agriculture-related activities, 7% in trade, and 33% were unemployed. Furthermore, 78% reported insufficient income for their livelihoods, while the remaining 22% described their living standards as average. The study identified substantial potential for agribusiness development in Mullaitivu, particularly through expanding crop and livestock production and developing value-added products to meet growing domestic and international demand. However, this potential is hampered by key challenges, including inadequate access to finance, limited technology adoption, a shortage of skilled labor, and insufficient infrastructure. This study concludes that agribusiness holds significant potential for revitalizing Mullaitivu's rural economy. However, realizing this potential requires addressing key challenges through increased access to finance, improved infrastructure, appropriate technology transfer, and skills development for farmers and agribusiness entrepreneurs. The study recommends implementing capacity-building programs, improving market access facilities, providing subsidized loans and grants, and targeted policy interventions. By capitalizing on identified opportunities and overcoming these obstacles, agribusiness can significantly contribute to poverty reduction and improved living standards in Mullaitivu's rural communities.

Impacts of Remote-Working Arrangements on Business Performances in the Non-Banking Financial Sector in Sri Lanka.

Chamil Prasad

Abstract

The transformation of business systems from physical environments to remote working arrangements is a phenomenon currently experienced worldwide. Therefore, the current study attempts to examine the impacts of remote working arrangements on business performance in the non-banking financial sector in Sri Lanka. The unit of analysis is composed of individuals and 300 remote-working employees from different companies under non-banking financial sector IDs drawn from the population conveniently. The data was analysed through SPSS 21.0. The empirical results revealed that remote working arrangements positively and significantly influence the business performances of individuals and the dimensions of job roles, employee satisfaction, and work-life stress. Consequently, the current paper recommends that remote work arrangements be given importance to employees to positively influence business performance.

Keywords

Work from home (WFH), Remote work, Non-banking Financial Sector (NBFS), Information Communication Technology (ICT), Cyber Security, Business Performances, Hybrid work arrangement, flexible working arrangement.

Introduction

Being the number one performing company in the industry based on business performance, has become one of the most common and popular trends among businesses. Amongst all the companies in the different industries, the financial sector for any country is considered as an important pillar in its economic activities as it can finance institutions and households. With the pandemic situation prevalent within the world remote-working emerged the mostly used method by companies to continue with their business.

Understanding the modality and the other important considerations such as cost reductions, identification of job roles, employee engagement and satisfaction and work-life balance in the context of improved business performances of NBFIs in Sri Lanka is very important in the process of implementing it and needs to understand the impacts on these elements on business performances of Non-Banking Institutions. The general objective is to examine the impacts of remote working arrangements on business performance in the non-banking financial sector in Sri Lanka. There are four specific objectives of the study. Firstly, to study the characteristics and dimensions of JOB roles for remote work adoption in the context of improving business performances in NBFIs. Secondly, to examine the impact of operational cost reductions through WFH adoption in the context of improved business performances in NBFIs. Thirdly, the positive impact of employee satisfaction due to WFH in the context of improved business performances in NBFIs will be discussed. Fourthly, to examine the positive impact of work-life stress due to WFH in the context of improved business performances in NBFIs.

Literature Review

Remote working or Work from home concept is a new kind of flexible working arrangement, and employees would be able to perform their jobs flexibly while being in their home-

working environment (CIPD, 2016). As stated in the labour e – E-Survey March 21 & CBSL annual report 2020, in a Sri Lankan context Work-from-home can be an instrument for economic growth in the long run. This can be achieved through reduced carbon emissions. Thus, positive impacts on the environment reduced traffic congestion, less fuel consumption, and fewer oil imports because of fewer vehicle movements. Also, in the end, Sri Lankans can benefit from reducing urbanization and other related advantages if the WFH arrangement can be taken up at the national level.). Up until the year 2020, Working from home as an alternative option to continue with has not been discussed widely, and with the use of it due to COVID-19 implications, acceptance to Work from home came into effect in the Sri Lankan context. During this particular period, government sector employees were managed in line with public sector directives, and there were considerations in the private sector employees and employers to manage WFH arrangements due to the non-availability of pieces of necessary labour-related legislation (Samarakoon et al. 2020). Caves 2004 & Bhattarai 2020 opined that it is not a new concept. Within the online working environment, maintenance of employee engagement and business performance is vital and considered a challenge. Thus, the factors that influence business performance need to be explored further. Factors such as Identification of job roles, Employee Satisfaction, Digitalization and Work-life distress can influence the business performance of non-banking financial companies.

Identification of Job Roles

Selection or identification of jobs suitable for remote working is made carefully based on important considerations. When it comes to remote working jobs, it categorised under two parts as WFH-friendly jobs and non-friendly jobs. Selection of the most suitable jobs will impact the success of the WFH implementation in a company. It is stated that workers' ability to work from home depends on various factors such as contractual obligations, work time, the intensity of work delivery, workplace flexibility, and working culture, and management trust plays a vital role among the many other considerations (Gschwind & Vargas, 2019). In identifying job roles for WFH implementation, it is important to have a better understanding of occupational grouping and job tasks. Many developed countries have more suitable jobs for the WFH model compared to less developed countries, which can be significantly seen in the studies conducted in European countries. It can be proven by the research studies conducted in higher developed countries such as Switzerland, Luxembourg, and Norway, and Sweden has a higher number of jobs suitable for the WFH model compared to less developed countries such as Romania and Turkey. Therefore, it is understandable that the possibility of WFH by lone parents is at the highest level. Gender has a strong correlation with possible WFH jobs, especially female members who are more likely to have WFH opportunities than their counterparts. The ability to work from home is more concentrated on highly skilled and highly educated workers, including occupations that are identified to have highly skilled and highly educated individuals (McKinsey, 2020). It is also important to understand that some jobs require collaborating with other jobs to fill the overall job responsibilities of a certain occupation. According to the analysis done by McKinsey, it is identified that over 2000 job activities in more than 800 occupations are based on O+ net (Occupational information net).

Digitalisation

The COVID-19 pandemic accelerated the adoption of remote work and digital technologies, significantly changing how businesses operate and employees work. The impact of digitalization on the WFH modality has potential benefits and challenges along with general trends such as Increased Flexibility and Autonomy, where Digitalization has enabled employees to work from any location with an internet connection. This flexibility can enhance work-life balance and increase autonomy for workers. A study by Smith et al. (2020) found that remote workers reported higher job satisfaction and reduced work-

related stress due to increased control over their work environment. Digital tools such as video conferencing, instant messaging, and project management software have improved remote communication and collaboration. Research by Johnson and Wang (2019) demonstrated that digital communication tools help bridge communication gaps among remote teams, leading to improved task coordination and knowledge sharing. The impact of digitalization on productivity in the WFH modality has been debated. A study by Brown and Peters (2018) suggested that remote work can increase productivity due to reduced distractions and commuting time. However, there are also concerns about potential decreases in productivity due to isolation and blurred work-life boundaries (Golden, 2020). Digitalization allows companies to tap into a global talent pool without geographical constraints. This can lead to improved recruitment outcomes and talent diversity. A report by Deloitte (2021) emphasized that remote work options can enhance an organization's attractiveness to potential employees, especially among younger generations. While digitalization has brought numerous benefits, it has also presented challenges. Research by Greenfield and Davis (2017) highlighted potential feelings of isolation and reduced social interaction among remote workers. Maintaining work-life boundaries can also be difficult, leading to burnout (Kossek et al., 2020). Remote work relies heavily on digital tools, raising concerns about data security and privacy. Research by Li et al. (2018) emphasized the importance of implementing robust cybersecurity measures to protect sensitive information when employees work remotely. In conclusion, digitalization has significantly impacted the work-from-home modality, reshaping how work is conducted and altering workplace dynamics. The benefits of increased flexibility, communication, and talent acquisition are counterbalanced by challenges such as isolation, blurred boundaries, and security concerns. The evolution of digital technologies will likely continue to shape the future of remote work.

Employee Satisfaction

As defined by Locke (1969), job satisfaction can be defined as positive emotions and pleasurable attitudes towards a job. As expressed by Mahesh Kumar and Jayaraman 2019 Job satisfaction can be defined as attitudes towards their work, organization, rewards and the social and organizational environment. As stated by Ford and Butt – 2017, there are possibilities that employees can modify the day to day activities in relation to work or family based on necessities; thus, staff can enjoy greater levels of flexibility when they WFH (Wienclaw, 2019). As claimed by Ford & Butt (1991), avoiding commuting during rush time has been seen as one of the most advantageous by staff when they WFH. As highlighted by Beauregard et al. (2013), the satisfaction and commitment of work-from-home employees are higher than those of employees who are working at the office. Apart from flexibility and autonomy in task fulfilment and work schedule, they are also seen as positive aspects for staff on remote work arrangements (Crawford et al, 2011; Beauregard et al, 2013 ;) As explained by Schall (2019) in common employees who are chosen to be a part of work from are more engaged, enthusiastic and committed towards their responsibilities than the other employees and these subsequently have an impact on employee satisfaction level. Satisfied employees have a strong psychological bond with the organization and are proud of being a part of the organization (Rahayu et al., 2018). Organizations are also should focus more on activities in order to engage employees effectively when staff are on work from home mode by providing necessary communications, feedback and support wherever possible which eventually has an impact on the overall satisfaction level of staff members (Fonner & Roloff, 2010)

Work-Life distress

The work-from-home modality has become increasingly prevalent, especially with the onset of the COVID-19 pandemic. While it offers benefits such as increased flexibility and reduced commute times, it also presents challenges that can lead to work-life

distress. Some impacts include blurring work-life boundaries, increased workload and overworking, social isolation, and lack of work-life balance. With the physical separation of the workplace and home environment becoming less distinct, individuals may find it difficult to establish clear boundaries between work and personal life. This blurring can lead to feelings of being constantly connected to work, resulting in higher levels of stress and distress. Remote work can sometimes lead to an increased workload, as employees might find it harder to switch off work tasks. The lack of physical separation between the office and home can make setting limits on working hours challenging, potentially leading to burnout and distress. Remote work can lead to isolation and loneliness due to reduced face-to-face interactions with colleagues. The absence of social interactions occurring naturally in a physical workplace can contribute to detachment and distress. While the flexibility of remote work can allow employees to manage personal responsibilities more easily, it can also lead to challenges in achieving a healthy work-life balance. Working tasks with household responsibilities can be overwhelming, contributing to work-life distress. The rapid transition to remote work often involves increased reliance on technology and digital communication tools. This can result in technostress, where individuals feel overwhelmed or anxious about using these tools effectively, adding to their overall work-life distress.

Business Productivity

Managing an organisation's business performance provides a complete overview of the organization's engagement in achieving its desirable objectives and expectations. Practitioners and academia Cross & Lynch have studied different business performance measurements, (1998). Initially, Business measurement models were limited to financial dimensions (E.g. Traditional controlling methods). Kaplan & Norton (1996, 2001) introduced the best-known multi-dimensional performance measurement model, and it includes dimensions such as financial perspectives, Customer perspectives, and Organizational perspectives, Internal Business process perspectives Learning and growth Perspectives that are very useful for organizations to manage business performances. As expressed by Dumas et al. (2013), it is also important to have business process management in the organization as it provides a foundation for measuring operational activities, decisions made, and other events that impact organizational effectiveness and business performance. As opined by Neely et al. (2000) and Richard et al. (2009), performance indicators are organizationally dependent and should derive based on organizational strategies, objectives, mission and vision and should make sure to combine both financial and non-financial business performance dimensions. As opined by Lupu (2017), a significant number of companies are facing challenges in commuting to work daily. can see contribution, also can be included in the total contribution of employees for the company Ford & Butts (1991). Wienlaw (2019) claimed a notable reduction in absenteeism by staff members working from home. If staff has sick children or elderly people at home, they can manage their work while working from home Lupu (2019)

Methodology

This research was based on the responses collected from a sample of 300 employees who are currently experiencing the remote working concept. The researcher has selected the most relevant articles published from the 1990s to 2023. Data collected was critically analyzed using SPSS 23 on the impacts of remote working arrangements on business performance in the non-banking financial sector in Sri Lanka.

Methodology

This research was based on the responses collected from a sample of 300 employees who are currently experiencing the remote working concept. The researcher has selected the most relevant articles published from the 1990s to 2023. Data collected was critically

analyzed using SPSS 23 on the impacts of remote working arrangements on business performance in the non-banking financial sector in Sri Lanka.

Conclusions and Recommendations

The current study emphasizes the importance of remote working arrangements on business performance in the non-banking financial sector in Sri Lanka. Thus, steps should be taken within the non-banking financial sector to improve the capability of remote working arrangements and find some strategies that managers could use to overcome the issues that occur when introducing remote working arrangements. The managers should be given training to engage in remote working arrangements. Within the virtual environment, managers need to personalize the office rooms for employees; this could be done by creating chat rooms related to the topics and providing personalized feedback when discussing projects and departmental-related issues. These would motivate the employees to engage more with the work. Further, unlike within the physical environments, the managers need to be flexible in relation to the employees' work as employees are struggling with the current challenges (for example, the signal issues, not having infrastructure, etc.). The managers must create an open environment where employees can raise concerns and enjoy their virtual working experiences by enhancing their engagement. This will result in them reducing the boredom, anxiety and stress that is present among the employees through continuous online engagements. This was conducted in a controlled environment where only the Sri Lankan non-banking financial sector employees were selected as the sample. The researcher has been facing difficulties finding previous research articles since only a few articles are based on the specific topic area. Choosing an appropriate model for the research was also hard since the model based on the topic is outdated. Further, the study was cross-sectional, where the data was collected only once. This will result in the inability to monitor the changes over a period of time.

The Impact of Level of Integrated Reporting Compliance on Firm Performance and Firm Value: Evidence from Sri Lanka

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Introduction

The emergence of integrated reporting (IR) represents a significant shift in corporate communication strategies, emphasizing a holistic view of firm performance that includes both financial and non-financial information. This shift has become particularly relevant in the post-financial crisis era, where stakeholders increasingly demand transparency and accountability beyond traditional financial metrics. This study aims to explore the relationship between the level of compliance with integrated reporting frameworks and firm performance and value within the context of Sri Lanka's banking and insurance sectors. Investigating this relationship is crucial, as understanding how IR compliance impacts financial outcomes can guide firms in their strategic decision-making processes and enhance their market positioning.

In existing literature, integrated reporting combines sustainability, governance, and traditional financial reporting, becoming a vital tool for firms aiming to attract stakeholder support and improve competitiveness. The essence of this study is to evaluate specific performance indicators such as Return on Equity (ROE) and Debt Ratio, alongside firm value measured through Market Capitalization. The research aims to discern whether increased compliance with IR correlates positively with these key performance indicators. Given the varying outcomes of studies conducted in different contexts, this research will provide pertinent insights into the Sri Lankan landscape, where IR is still gaining traction.

Literature Review

A considerable body of research has emerged surrounding integrated reporting, underscoring its relevance in improving stakeholder relationships and enhancing corporate accountability. Integrated reporting aims to convey how an organization's strategy, governance, and performance contribute to broader value creation over time. Several studies advocate that integrated reporting promotes transparency and compels organizations to reconsider their value creation process, aligning it more closely with stakeholder interests. For instance, Bhimani, Silvola, and Sivabalan (2016) highlight the necessity of addressing sustainability within the financial reporting framework due to increasing societal pressures for corporate accountability.

Moreover, Thorne, Mahoney, and Manetti (2014) emphasize that integrated reports should not merely synthesize financial and non-financial information but should represent an organization's strategic vision and operational efficiency. Affective change has also been documented in the attitudes of investors and analysts towards firms that adopt IR practices since such disclosures provide a more nuanced understanding of firm performance and risk. These studies point to the notion that organizations that proactively engage in IR can build stronger reputations and potentially enjoy better financial outcomes.

On the contrary, research by Bijlmakers (2018) reveals diverse perspectives, suggesting that

while some firms see improved performance with IR compliance. There is inconsistency across sectors and geographical locations. Pathiraja and Priyadarshanie (2019) found in their study of Sri Lankan firms that the adoption of integrated reporting is still moderate, and the factors influencing compliance reflect the unique challenges faced by developing economies, such as limited resources and a lack of regulatory frameworks supporting IR.

An emergent theme in the literature suggests that firms need to leverage integrated reporting not just for compliance but as a strategic tool for enhancing overall performance management and stakeholder communication. Many scholars underscore that it is imperative for firms to develop integrated reports that resonate with stakeholders' needs and expectations, as the utility of integrated reporting largely hinges on its ability to inform and engage diverse audiences.

Author(s)	Year	Context	Key Findings
El-Deeb	2019	Egypt	Positive impact on performance metrics like ROE.
Pathiraja & Priyadarshanie	2019	Sri Lanka	Moderate levels of IR adoption; factors affecting compliance identified.
Lee & Yeo	2015	South Korea	Positive correlation between IR disclosures and firm value.
Bhimani et al.	2016	Global Context	IR fosters accountability; aligns corporate strategy with stakeholder interests.
Thorne et al.	2014	Global Context	Emphasizes strategic vision in IR, promotes operational efficiencies.
Bijlmakers	2018	Netherlands	Mixed results on performance impact; context-dependent.

Table 1: Summary of Previous Research on Integrated Reporting Impact

Methodology

The research employs a quantitative methodology, focusing on data from 12 banks and 9 insurance companies listed on the Colombo Stock Exchange (CSE). This selection allows for an exploration of IR compliance in sectors that are both critical to the economy and increasingly under scrutiny from stakeholders. The study spans five years, from 2015 to 2019, utilizing publicly available reports and disclosures to gather data on integrated reporting practices.

The research design involved developing an Integrated Reporting Index (IRI) based on leading global practices and guidelines outlined in the International Integrated Reporting Framework released by the IIRC. A total of 50 elements were extracted from existing literature to assess the quality and comprehensiveness of each firm's integrated report. The performance metrics analyzed include Return on Equity (ROE), Debt Ratio (DR), and Market Capitalization, providing a multifaceted view of financial health.

Data analysis was conducted using statistical tools such as SPSS for regression analysis and correlation coefficients to establish the relationships between IR compliance and the defined performance indicators. This analysis is anchored on the hypotheses that greater IR compliance correlates positively with enhanced company performance, as measured by ROE, and increases in firm value as captured by Market Capitalization.

Findings

The analysis yielded a nuanced understanding of the relationship between integrated reporting compliance and performance metrics within Sri Lanka's banking and insurance sectors. The statistical outcomes reveal interesting trends regarding the effects of IR compliance on financial performance indicators.

SPSS Analysis Results

Model	Independent Variable (IR Index)	Dependent Variable (ROI, DR, MC)	Coefficient	p-value	R-squared
Model 1 (ROE)	IR Index	ROE	-0.235	0.307	0.034
Model 2 (DR)	IR Index	Debt Ratio	-0.150	0.214	0.022
Model 3 (MC)	IR Index	Market Capitalization	0.180	0.502	0.042

Table 2: SPSS Regression Outcomes

The results indicate that:

1. Return on Equity (ROE) showed a negative relationship with the IR Index, suggesting that despite increased compliance with integrated reporting practices, firms did not experience improvements in profitability as measured by ROE. The p-value indicates statistical insignificance ($p > 0.05$), confirming that the null hypothesis cannot be rejected in this model.
2. Debt Ratio (DR) similarly produced a negative coefficient. This outcome signifies that higher compliance with integrated reporting does not correlate positively with lower leverage or debt utilization, which may imply that firms are not utilizing IR disclosures effectively to manage debt.
3. Market Capitalization (MC) exhibited a positive coefficient with the IR Index; however, the relationship remains statistically insignificant. This finding suggests a potential for integrated reporting to enhance market valuation, though it is not enough to conclude definitively that IR compliance enhances firm value.

Discussion

The implications of these findings suggest a discrepancy between regulatory compliance and actual financial performance. The observed negative associations raise essential questions about the role integrated reporting plays within firms, especially in a developing market context like Sri Lanka. The effectiveness of IR might be hindered by several factors, including inadequate engagement with stakeholders, the perceived quality of disclosures, or the influence of market-specific factors that obscure the benefits of IR practices.

Organizations should capitalize on the reputational benefits of IR by ensuring that their integrated reports enhance stakeholder trust and provide credible, clear, and actionable insights. Yet, companies must also address gaps in performance metrics by focusing on how they leverage IR to influence operational efficiencies and strategic decision-making.

The limitations of this study include the narrow sector focus and the temporal challenges associated with evolving reporting standards, which may not capture the long-term benefits of integrated reporting. Future studies should broaden their scope to include a variety of sectors and utilize qualitative methodologies to capture deeper insights into the motivations behind integrated reporting practices.

Conclusion

In conclusion, this research contributes to the understanding of integrated reporting's impact within the Sri Lankan financial sphere. While positive aspects of correlated value perception are evident, the findings suggest the need for a cautious approach to interpreting the effects of IR compliance on performance. The results underline the necessity for further research to dissect the complexities influencing the relationship between integrated reporting adoption and firm dynamics, particularly in developing economies.

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Assessing the Integration of ChatGPT in Sri Lankan Business Environments: An Application of the Technology Acceptance Model (TAM)

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Abstract

The study explores the integration of ChatGPT in Sri Lankan business environments, emphasizing its transformative potential in automating communication, streamlining decision-making and enhancing overall efficiency. As Sri Lanka navigates digital transformation, understanding how businesses adopt and utilize AI-driven solutions is crucial. This research applies the Technology Acceptance Model (TAM) to assess the perceived usefulness, ease of use and behavioral intention of businesses in adopting ChatGPT. The study aims to identify both the opportunities and challenges faced by Sri Lankan enterprises in leveraging AI technologies to improve productivity and competitiveness. A comprehensive review of existing literature highlights global trends in AI adoption, demonstrating how industries worldwide have successfully integrated ChatGPT for business operations. The Technology Acceptance Model serves as the theoretical foundation to analyze adoption behaviors. The literature suggests that while businesses benefit from AI's ability to enhance operational efficiency, automate customer service and optimize knowledge management, challenges related to technological readiness, regulatory policies and workforce adaptation remain. In the Sri Lankan context, early adopters in banking, e-commerce and telecommunications have embraced AI-driven automation, but widespread implementation is hindered by infrastructural and educational limitations. The study employs a mixed-method research design, incorporating both qualitative and quantitative data collection methods. Surveys and interviews were conducted among business professionals, including corporate leaders, IT specialists and customer service managers, to evaluate their perceptions of ChatGPT adoption. Case studies from Sri Lankan businesses provide insights into real-world applications and highlight sector-specific challenges. The research methodology ensures a balanced analysis of user acceptance levels, industry trends and key factors influencing ChatGPT implementation in Sri Lanka. The findings indicate that Sri Lankan businesses acknowledge the benefits of ChatGPT in reducing operational costs, improving customer engagement and increasing overall efficiency. Industries such as finance, hospitality and retail have demonstrated interest in AI-driven solutions, leveraging ChatGPT for customer support automation and data-driven decision-making. However, the study identifies significant challenges, including inadequate digital infrastructure, lack of AI expertise and regulatory uncertainties. Many businesses, particularly small and medium enterprises (SMEs), struggle with limited access to AI resources, while concerns about data security and ethical AI use remain prevalent. The research highlights key challenges in ChatGPT adoption within Sri Lanka. Limited technological infrastructure, including inconsistent internet access and high AI deployment costs, restricts businesses from fully embracing AI solutions. The absence of well-defined AI regulations creates uncertainty regarding data protection, intellectual property rights and compliance with international standards. Furthermore, workforce resistance poses another barrier, as employees fear AI-driven automation could lead to job displacement. These challenges underline the need for a structured approach to AI integration, addressing both technological and human factors. To foster AI adoption in Sri Lanka, several strategic recommendations

are proposed. The government should establish clear AI policies that promote ethical AI practices while ensuring data privacy and security. Investment in digital infrastructure, including better internet connectivity and cloud computing services, is essential for enabling businesses to deploy AI solutions efficiently. Encouraging AI education and workforce training programs will help mitigate employee resistance and enhance overall AI literacy. Additionally, fostering collaborations between businesses, technology providers, and policymakers can accelerate AI innovation and create an ecosystem conducive to responsible AI adoption. The study concludes that while ChatGPT presents significant opportunities for Sri Lankan businesses, overcoming technological, regulator and workforce-related barriers is critical for successful implementation. By investing in AI infrastructure, establishing supportive regulations and promoting AI literacy, Sri Lanka can enhance its digital transformation journey and strengthen its competitive position in the global economy. The findings underscore the importance of a collaborative approach among stakeholders to maximize the benefits of AI-driven business solutions.

Keywords

ChatGPT, Technology Acceptance Model (TAM), Business Environment, Technology Adoption, Regulatory Challenges

The Impact of Digital Transformation in Higher Education: A Study on Academic Performance as a Key Performance Indicator

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Abstract

In recent years, the landscape of higher education has undergone a profound transformation due to the advent of digital technologies. Digital transformation (DT) refers to the integration of digital technologies into all aspects of education, fundamentally altering how institutions operate and deliver learning experiences This research delves into the implications of DT in higher education, with a particular emphasis on academic performance as a key performance indicator (KPI). Academic performance is often measured through grades, graduation rates, and student retention, making it a critical area of focus for educational institutions aiming to enhance their effectiveness and competitiveness.

Keywords

Digital Transformation, Key Performance Indicators, Student Engagement

Introduction

The COVID-19 pandemic has acted as a catalyst for this transformation, forcing educational institutions worldwide to pivot from traditional face-to-face learning to online and hybrid learning environments. The abrupt transition highlighted the necessity for institutions to adapt quickly to digital tools and methodologies. This shift not only changed the way education is delivered but also raised questions about the effectiveness of online learning compared to traditional classroom settings. This research aims to address these questions by investigating how digital transformation impacts academic performance and identifying the factors that contribute to successful outcomes in an increasingly digital educational environment.

One of the key factors examined in this study is internet access. The availability and reliability of internet connectivity are crucial for students to engage with online learning platforms effectively. In many regions, including Sri Lanka, disparities in internet access can create significant barriers to learning. This research analyzes how these disparities influence academic performance, particularly in rural versus urban settings. By understanding the role of internet access, institutions can develop targeted strategies to improve connectivity and ensure that all students have equal opportunities to succeed in a digital learning environment.

In addition to internet access, the study explores the importance of software and hardware support in facilitating digital learning. The availability of appropriate devices, such as laptops and tablets, as well as access to educational software, plays a vital role in determining students' ability to engage with course materials. This research investigates the extent to which institutions provide technological support to students and how this support correlates with academic performance. By identifying gaps in resources, educational institutions can implement initiatives to enhance technological access and support, ultimately leading to improved learning outcomes.

Student engagement is another critical factor in the context of digital transformation. The shift to online learning has presented unique challenges in maintaining student motivation and participation. This research examines various strategies that institutions can employ to foster student engagement in digital learning environments. These strategies may include interactive online activities, collaborative projects, and the use of multimedia resources to create a more dynamic learning experience. By analyzing the relationship between student engagement and academic performance, the study aims to highlight best practices that can enhance the effectiveness of online education.

The research methodology involves collecting and analyzing data from selected schools in Sri Lanka. By focusing on a specific geographic context, the study aims to provide insights that are relevant to local educational institutions while also contributing to the broader discourse on digital transformation in higher education. The data collection process includes surveys, interviews, and academic performance metrics, allowing for a comprehensive analysis of the factors influencing student success in a digital learning environment.

Data analysis is conducted using statistical software such as SPSS, which allows for the application of various statistical techniques to assess the relationships between the identified variables. Descriptive statistics will be used to summarize the demographic data and academic performance metrics, while inferential statistics, including regression analysis and correlation coefficients, will be employed to explore the relationships between internet access, technological support, student engagement, instructional quality, and academic performance. This quantitative approach will be complemented by qualitative research techniques, such as interviews and focus groups, to gather insights from educators and students regarding their experiences with digital learning environments. This mixed-methods approach will provide a holistic understanding of the impact of digital transformation on academic performance.

The findings of this research are expected to reveal significant correlations between internet access, software and hardware support, student engagement, instructional quality, and academic performance. These insights will underscore the importance of developing effective digital strategies that address the unique challenges posed by digital transformation. Educational institutions that prioritize these factors will be better equipped to navigate the evolving educational landscape and enhance the quality of education they provide.

Ultimately, this study aims to serve as a guide for institutions seeking to implement digital transformation initiatives. By providing evidence-based recommendations and best practices, the research will empower educational leaders to make informed decisions about technology integration and pedagogical approaches. As higher education continues to evolve in response to technological advancements, understanding the impact of digital transformation on academic performance will be essential for ensuring that institutions can meet the needs of their students and prepare them for success in a rapidly changing world.

The impact of digital transformation in higher education is a multifaceted issue that requires careful consideration of various factors influencing academic performance. As institutions strive to adapt to the demands of the digital age, this research highlights the critical role of internet access, technological support, student engagement, and instructional quality in fostering positive educational outcomes. By addressing these factors, educational institutions can enhance their effectiveness and ensure that all students have the opportunity to thrive in an increasingly digital learning environment. Through this exploration, the study aims to contribute valuable insights to the ongoing

conversation about the future of higher education and the role of digital transformation in shaping that future.

Green Entrepreneurship and Sustainable Business Models: Bridging Profitability and Environmental Responsibility

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Abstract

The increasing urgency of environmental concerns has reshaped global business practices, leading to the rise of green entrepreneurship¬–a model that merges economic viability with sustainability. Traditional business models often prioritize short-term financial gains at the expense of environmental well-being, resulting in resource depletion, ecological degradation, and social disparities. In contrast, sustainable business models, driven by eco-innovation and the Triple Bottom Line (TBL) framework, aim to balance economic, social, and environmental objectives. However, the challenge remains: how can businesses achieve profitability while maintaining environmental responsibility? High operational costs, policy gaps, and market resistance continue to hinder the large-scale adoption of sustainability-driven innovation. This study explores how sustainable business models, circular economy principles, green supply chain management, and carbon-neutral strategies can create long-term competitive advantages while addressing global sustainability challenges. Despite rising consumer preference for eco-friendly products, many green startups struggle to achieve market success due to limited financial resources, high initial investment costs, and difficulties in competing with well-established corporations. While green finance and impact investing are gaining traction, many financial institutions still perceive sustainability-driven businesses as high-risk ventures. Additionally, the absence of standardized Environmental, Social, and Governance (ESG) compliance frameworks has resulted in inconsistencies in sustainability reporting, making it difficult for businesses to measure and communicate their environmental impact effectively. The issue of greenwashing further complicates the landscape, as some companies falsely promote sustainability claims, leading to consumer distrust. To address these gaps, this research introduces an integrated framework incorporating regenerative business practices, sustainable brand positioning, and green entrepreneurship ecosystems to accelerate the transition toward sustainability-driven innovation. A mixed-methods research approach is employed in this study, combining a systematic literature review, case study analysis, and empirical data collection to examine green entrepreneurship's impact on financial success and environmental sustainability. Case studies of companies such as Tesla, Patagonia, and Unilever highlight best practices in green supply chain management and sustainable value creation. Additionally, financial data from ESG-aligned publicly traded firms are analyzed to assess the relationship between sustainability commitments and market performance. Consumer behavior surveys further explore the role of sustainable branding in shaping purchasing decisions and fostering brand loyalty. Findings indicate that companies integrating circular economy models, carbon-neutral business strategies, and regenerative practices experience cost reductions, increased investor confidence, and enhanced brand perception. Businesses that leverage green finance mechanisms and regulatory incentives demonstrate higher resilience and long-term profitability. Moreover, fostering sustainable entrepreneurship ecosystems, through a combination of government support, private sector initiatives, and consumer-driven demand,

accelerates the transition to a sustainable economy.

The study's insights have significant implications for policymakers, entrepreneurs, and investors. Governments should implement stronger regulatory frameworks, such as carbon pricing, tax benefits, and ESG disclosure mandates, to encourage sustainable business practices. Entrepreneurs must embed green supply chain management and sustainable brand positioning into their business strategies to attract eco-conscious consumers. Investors, in turn, should prioritize funding sustainability-driven enterprises to promote impactful innovation. Ultimately, this research underscores that green entrepreneurship is not only an environmental necessity but also a strategic pathway to financial success. By embracing sustainable business models, companies can achieve both profitability and ecological responsibility, ensuring a resilient and sustainable future.

Keywords

Green Entrepreneurship, Sustainable Business Models, Circular Economy, Eco-innovation, Triple Bottom Line (TBL), Green Supply Chain Management, Carbon-neutral Strategies, ESG Compliance, Impact Investing, Sustainable Brand Positioning

EDUCATION

The Psychological Study of The Impact of Parenting Styles on Children's Academic Performance in Sri Lankan International Schools

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Abstract

The present study examined into how ways of parenting, parental participation, and academic performance impact on Western province international schools' students. The study further examined differences between groups of parents in relations to their demographic background (gender and parents' education level). Children's academic success has been consistently correlated with ways of parenting and parental participation in academic-related events (Matejevic, Jovanovic, & Jovanovic, 2014; Spera, 2005). However, there is a need to broaden the study to non-Western educational contexts considering the relationship between ways of parenting, involvement of parents, and children's academic achievement has frequently ever been investigated within Western educational contexts. indicating the necessity of expanding the research to non-Western settings. 342 parents of the randomly selected students represent the sample for this mixed-methods study, which focuses on six (6) public international schools serving grades 4–7, with 157 (75%) responding to questionnaires. The sample was collected from six randomly selected primary schools, and a one-in-one systematic sampling method was employed to select children and their parents. The majority of parents were aged 41-50 years, with 117 (45.3%) in the 41-50 years age group, 38.4% in the 31-40 years age group, 8.5% over 50 years, and 7.8% in the 20-30 years age group.

Keywords

parenting style, academic performance, children's performance, authoritarian, parental involvement

Introduction

The majority of parents indicated grade 12 as their highest education level, with 83 (32.2%) indicating it. The majority of parents were employed, with 171 (66.3%) being employed, and 17.1% unemployed. The age groups for parents ranged from 20-24 to 50 or more. Only one parent or guardian needed to complete the questionnaire per household.

The study used the maximum variation sampling method to select interview participants, as school authorities expected well-informed participants to participate in the survey. The results showed that 67 (26%) of the parents identified themselves as fathers, 155 (60.1%) as mothers, 4 (1.6%) as grandparents, 30 (11.6%) as uncles, and 2 (0.8%) as 'other' parents.

Hennink (2014) found that a focus group with less than six discussants has less variety, while a group with more than eight can be more challenging for facilitators. To address this, 18 parents were selected for three interviews and three key informants (parents) from school board members for in-depth open-ended interviews. The study sample for qualitative analysis consisted of 21 participants, including 18 parents for focus group interviews and three key informants.

Using the 32-item Parenting Styles and Dimensions Questionnaire (PSDQ) of Robinson et al. (2001), authoritative, authoritarian, indulgent, and neglectful have been evaluated according to with Baumrind's (1966, 1991) framework. Parents' observations and views

about how they participate in their children's school activities were examined through a modified 24-item scale based on six categories of parent participation: "parenting, communicating, volunteering, learning at home, decision making, and collaborating with the community" (Eesuola, 2018, p. 54). In respond to question 7 of the questionnaire on the parents' demographic background, parents' reports of their children's achievement level were analyzed to evaluate their academic performance.

The study involved collecting data from six international schools in the Western province using a structured questionnaire. The questionnaire was developed to elicit information from parents, manage data through statistical analysis, and allow for generalizability of the sample to the wider population. Benefits of questionnaire-based data gathering include cost-effectiveness, less time-consuming, and less labour-intensiveness. It also allows for the collection of considerable amounts of data within a relatively short time and offers greater anonymity.

Part A of the survey contained parents' demographic information and assessed their perceptions of their children's achievement level. Part B and C explored parents' experiences with parenting styles and parental involvement in their children's educational activities. The questionnaire included both open- and closed-ended questions, with Likert scale questions ranging from 1= Never to 6= Always.

The quantitative dimension utilized a questionnaire to solicit views from parents about their parenting styles and their involvement in the education of children. The data collection pattern in the study was QUAN□qual, with priority given to the quantitative phase.

The advantages of questionnaire-based data gathering include cost-effectiveness, less time-consuming, and less labour-intensiveness. Closed-ended questions were cleaned to ease data analysis using the Statistical Package for Social Sciences (SPSS).

The data from closed-ended questions was analyzed by multiple linear regression analysis, principal components analysis (PCA), Pearson correlations, one-way analysis of variance (ANOVA), cluster analysis, and cross tabulation with chi-square test. The twenty-one (21) participants in the investigation sample for the qualitative analysis included three (3) key informants (school board members), who had been selected for the in-depth open-ended interviews, and eighteen (18) parents for the focus group interviews. Six phases of thematic analysis were utilized to analyze the data from the interviews (Braun & Clarke, 2006). Research results indicated that there was a significant correlation between the school performance of the children in the general population and parenting style and involvement by parents. Academic achievement was found to be associated with an authoritative parenting style. Strict parenting, however, was found to be negatively correlated with the academic achievement of children. The main findings emphasize that in order to enhance a child's academic performance, parents must avoid extreme forms of parenting and encourage authoritative, kind, and supportive parenting—later known as "firm" parenting—as well as consistent parental involvement in education.

The study examined the relationship between parenting styles and parental involvement in school activities. Results showed that authoritative parenting styles (warmth/support) and democratic participation had a low but positive correlation, with warmth and support accounting for 4.6% of the variance in child behavior control. Children from authoritative families performed better in school compared to those from other parenting environments. Reasoning and induction and democratic participation parenting styles were less correlated with monitoring and supervision and encouraging and praising. Democratic participation creates a sense of good will and mutual

understanding, enhancing parental involvement in school. The authoritative parenting approach (physical coercion) was negatively associated with school-based involvement activities, such as communication (4.2%). Verbal aggressiveness had a significant but negative correlation with monitoring and supervision (2.6%), and indulgent parenting was negatively correlated with monitoring and supervision (3.8%) and control of child behavior (2.8%). Verbal aggressiveness indicates relational dysfunction between parent and child, making it difficult for them to work in collaboration, negatively impacting parent engagement in school work.

The study found that monitoring and supervision of children's school work at home had the most significant effect on their academic outcomes. Parents considered it right and proper for their children to receive school work at home, which supports previous research that individual types of parental involvement do not predict school results as much as the overall involvement. This may be because parents believe that children can only achieve well in school when their behavior towards school is nurtured by the parents.

Parents who supervise their children's schoolwork under an authoritative parenting method are more likely to help improve their children's educational attainment. Monitoring and supervision were higher among female participants than male participants in the study. One mother reported that female participants were more engaged in monitoring and supervising their children's schoolwork than male participants. This finding supports previous research showing that mother's engagement in school work is a key influential factor of children's school performance, but fathers' involvement had no predictive effect. Chinese mothers appeared to engage their children in deliberation about their future options, considering their child's opinions, following their progress with their schooling, and engaging in their educational matters. The data collected from all sources was triangulated, which helps reduce bias and cross-examines the integrity of participants' responses. Triangulation is defined as a practice of obtaining more reliable answers to research questions through integrating results from different approaches, where each approach has different key sources of potential bias that are unrelated to each other.

In conclusion, monitoring and supervision of children's school work at home has a significant impact on their academic performance. This study highlights the importance of parental involvement in shaping children's academic success. A gender and parenting style difference was identified based on the results obtained. It was found that fathers were more authoritarian and mothers more authoritative. According to the interview data, parents usually had high expectations for their children's performance in school, despite their educational background. The findings showed that mothers associated with their children in a more authoritative manner, which regularly raised their level of participation in school events and, in consequently, led to their children succeeding well. As consequence, the study suggests that schools encourage the development of partnerships between families and schools at home and in the classroom and raise awareness of the consequence that their involvement has on their children's educational performance.

The Divergence of Education Ordinance: An Educational Analysis

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Abstract

This paper presents the findings of three case studies that investigated the divergence of the Education Ordinance during the period of 1998 - 2023. A thorough review of the conditions stipulated in the ordinance was scrutinised while the three case studies were carried out to obtain exclusive data for this endeavour. In addition, available literature was incorporated to substantiate the claims of this paper. Focus group discussions were conducted with stakeholders (n=50) in the Central province, and recommendations are given to mitigate the issue.

Keywords

Education, Ordinance, Acts, Appointments, Establishments, Deviation

Introduction

Sri Lankan education system that evolved 2500 years ago was confined to the upper classes and the monks. However, the arrival of the Portuguese, Dutch and the English broadened the doors for all creating social mobility.

Inception of Education:
In 1833, subsequent to the recommendations of the Colebrook Commission, the British introduced a standardised system of education funded by the state under the recommendations of the committee. In addition to missionary schools local English medium schools were also established. The system was further strengthened in 1867 with the intervention of His Lordship, Bishop Christopher Bonjean, the Archbishop of Colombo. The sub-committee's report recommended enhancement of education while relieving restrictions to teach any religion and permitting any religious body to establish schools. [1]

Legislation Governing General Ediucation:
1930 marked a transitional period in education and continued until the introduction of the Education Ordinance No: 31 of 1939 which relegated the colonial power structure in educational administration to a considerable extent. Gunawardene (1989) mentions "The Education Ordinance No: 31 of 1939 still remains the basic law of education in Sri Lanka, despite several attempts to push the implementation of new policies over the past decades" [2]

Provisions of the Ordinance were amended under Act No. 61 of 1939, 21 of 1945, 3 of 1946, 26 of 1947 that steered the establishment of an Education Research Council, Act No:5 of 1951, 43 of 1943, 37 of 1958 and law No:35 of 1973 that govern general education, but the core conditions of the Ordinance No:31 of 1939 continues to be valid even today. Assisted Schools and Training Colleges Act No.5 of 1960, No:8 of 1961 and No:65 of 1981, Public Examinations Act No: 25 of 1968, Pirivena Education Act No. 64 of 1979, National Institute of Education Act No:28 of 1985, Colleges of Education Act of 1986 and NEC Act of 1991 were passed by Parliament since Independence.

Section 36 of Education Ordinance No: 31 of 1939 states (1) "The Director-General may appoint as the manager of an assisted school any person recommended in writing by the proprietor of the school and [3] The Director-General may, for reasons to be stated by him in writing and communicated to the proprietor of an assisted school, refuse to appoint as the manager of that school the person recommended by the proprietor and may require the proprietor to recommend some other person as manager."

Review of Literature

Although formal education was introduced in the 16th C, the first ordinance (No: 5) was introduced in 1906. It encouraged compulsory vernacular education in Sri Lanka. Subsequently, the Rural Schools Ordinance No: 8 of 1907 was introduced to enhance education in the vernacular languages in rural and planting districts. The latter included schools in which instruction was given in English, in addition to the vernacular.

Maro Gomez states that the legal protection given to the estates began with the Rural Schools Ordinance in 1907 and was continued by the 1920 Ordinance, through to the Ordinance No: 31 of 1939. Until the introduction of the 1920 Ordinance, there was no single comprehensive legislative enactment dealing with education and this enactment sought to consolidate all previous enactments. He adds that the 1920 Education Ordinance was a major legislative enactment of the British colonial regime. It was also the precursor to the current ordinance [4].

Angela W Little (2023) states that from 1931 to 1970 education policies were driven by the need to assert national control over an inherited colonial system and to create a unified system of education [5].

She goes on to state that Sri Lanka is hailed internationally for her achievements in literacy, educational enrolment and equality of educational opportunity. "However, progress has not been straightforward due to the complex interactions between politics, policy formulation, and the implementation of reforms". This proves the fact that ad hoc decisions were made to please a minority compromising the welfare of the majority in certain instances.

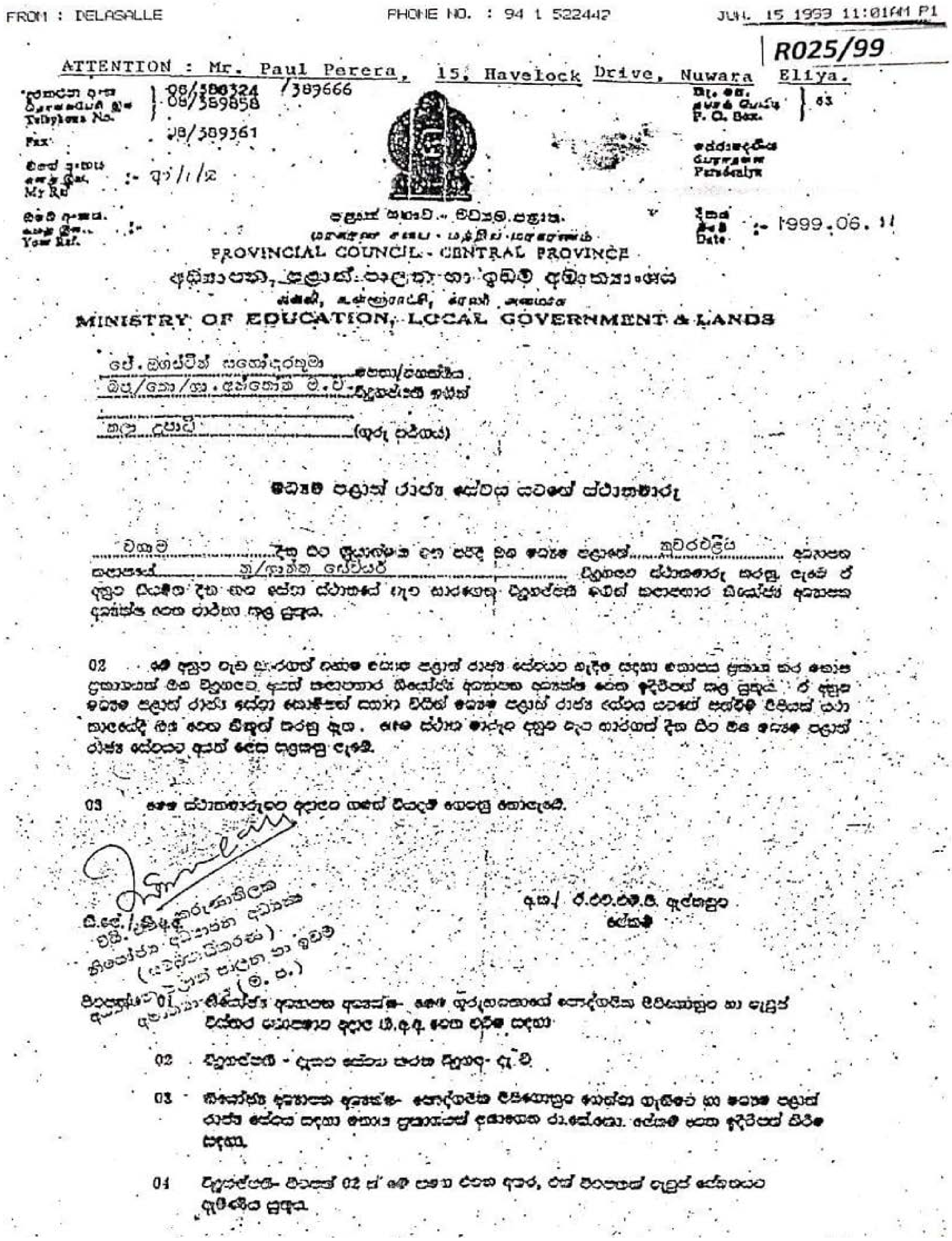
In a letter to the Minister of Education (2024) parents and members of the OBA in Nuwara Eliya request that an impartial and prompt inquiry to be conducted into the three cases under review, and other allegations that had finally downgraded the status of the school from 1AB to 1C in 2021 [6]. Further, the letter states that the students are deprived of the good services of qualified and experienced principals.

Wells and Bechard point out that the leadership of institutions contribute much towards the dropout rate. [7] This is a clear indication of the importance of the calibre and virtues of the leadership in guiding the destinies of a school.

Zahara Zuhair (2028) states that the Sri Lanka's existing education law No. 31 of 1939 needs to be modernised" [8].

Method and Materials

This study used a qualitative method to gather data through focus group discussions, interviews and review of literature. Participants were posed with questions without any prompting. Correspondence with regard to the appointment of the principals were thoroughly scrutinised and some quantitative data were used in compiling his paper. Interviews were conducted in order to cross check and explore the matter. An in-depth interview was conducted with a committee that spearheaded the appointment of the principals in question.


FROM : DELASALLE PHONE NO. : 94 1 522442 JUL. 15 1999 11:01AM P1

R025/99

ATTENTION : Mr. Paul Perera, 15, Havelock Drive, Nuwara Eliya.

Telephone No. 08/388324 /389666 08/389858

Fax 08/389361

P. O. Box. 63

Peradeniya

Date :- 1999.06.11

PROVINCIAL COUNCIL - CENTRAL PROVINCE

MINISTRY OF EDUCATION, LOCAL GOVERNMENT & LANDS

Fig: 1 : Central Provincial Ministry of Education

මධ්‍යම පළාත් සභාව

மத்திய மாகாண சபை

CENTRAL PROVINCIAL COUNCIL

The Chief Ministry and Provincial Ministry of Finance and Planning, Law and Order, Local Government and Provincial Administration, Human Resources, Education and Cultural Affairs, Tourism, Land, Trade and Commerce, Food Supplies and Distribution, Investment Coordination and Portfolios which are not taken under any other Ministries

පළාත් සභා සංකීර්ණය, පල්ලෙකැලේ, කුණ්ඩසාලේ.

மாகாண சபைக் கட்டடத் தொகுதி, பல்லேகலை, குண்டசாலை.

Provincial Council Complex, Pallekele, Kundasale.

විද්‍යුත් තැපැල / மின் அஞ்சல் / E-mail : chiefmin@cpcm.lk

වෙබ් අඩවිය / இ. தளம் / Website : www.cpcm.lk

අමාත්‍යාංශ කාර්යාලය அமைச்சு அலுவலகம் Ministry Office	081 - 4481322	ලේකම් செயலாளர் Secretary	081-2424938	ජ්‍යෙෂ්ඨ සහකාර ලේකම් சிரேஷ்ட உதவி செயலாளர் Senior Assistant Secretary	081-2424936	ප්‍රධාන ගණකාධිකාරී பிரதான கணக்காளர் Chief Accountant	081-2424935	ෆැක්ස් தொலைநகல் Fax	081-2424938

මගේ අංකය / எனது இல. / My No. සිපිසි/ශිඑම්එස්/1/30/1/9

ඔබේ අංකය / உமது இல. / Your No.

දිනය / திகதி / Date 2016.08.08

R298/16

නුවරඑළිය කලාප අධ්‍යාපන අධ්‍යක්ෂ මගින්.

ඇන්තනිස් ප්‍රැන්සිස් මයා.

ශ්‍රී.ලං.වි.සේ. III

මප/නු/ ජෝන්ටර් අනුස්මරණ විද්‍යාලය

නුවරඑළිය

ශ්‍රී ලංකා විදුහල්පති සේවයේ රාජකාරි ඉටු කිරීමට පත් කිරීම

<u>මප/නු/ ශාන්ත සේවියර් විද්‍යාලය</u>

ඉක්මන කරුණ සම්බන්ධයෙන් පළාත් අධ්‍යාපන අධ්‍යක්ෂගේ නිර්දේශ අනුව වහාම ක්‍රියාත්මක වන පරිදි ඔබ, මප/නු/ ශාන්ත සේවියර් විද්‍යාලයේ විදුහල්පති තනතුරේ රාජකාරි ඉටු කිරීම සඳහා පත් කරමි.

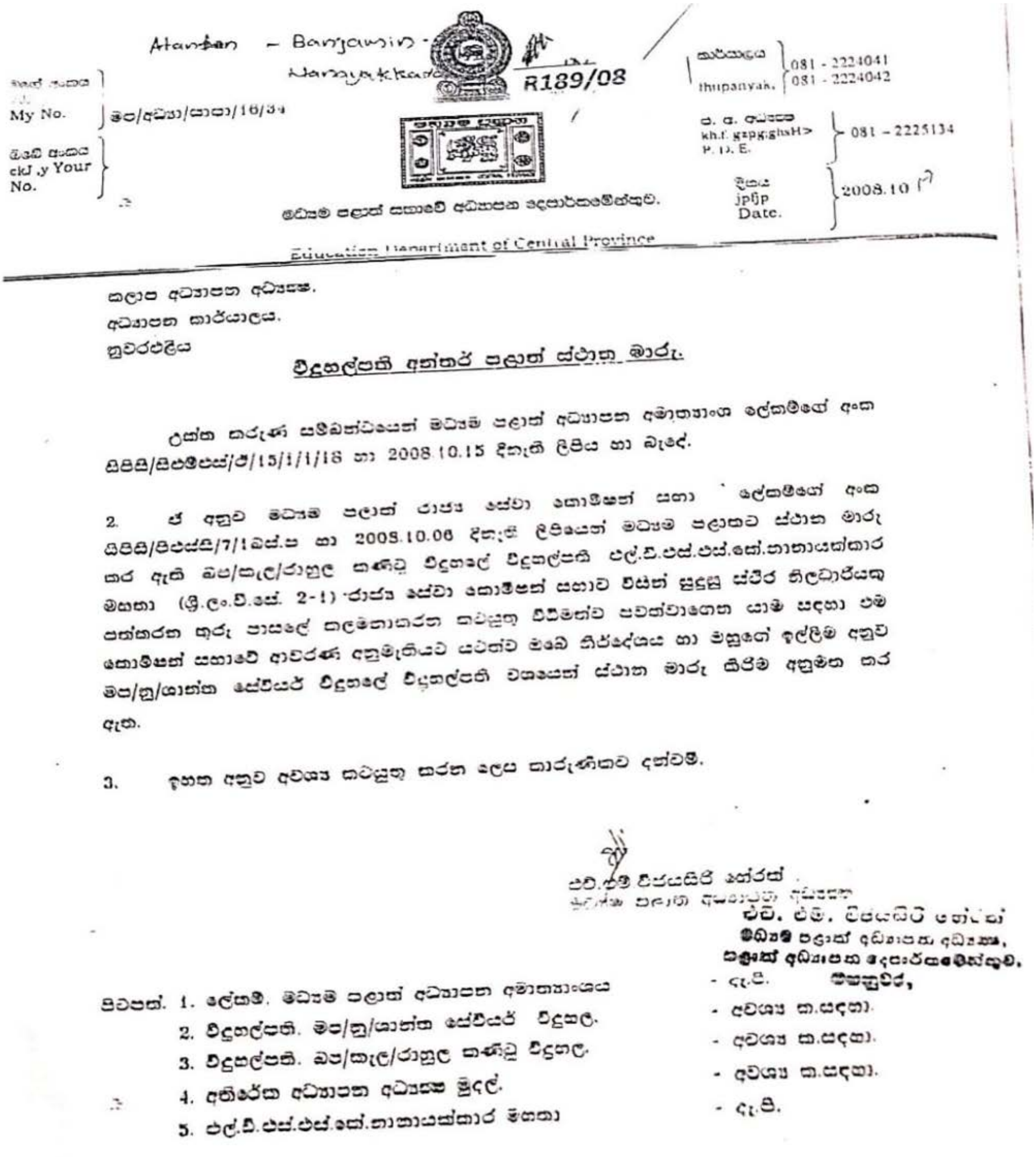
02. මෙම ලිපියට අනුව ඔබ, අදාළ තනතුරේ රාජකාරි භාරගෙන කලාප හා පළාත් අධ්‍යාපන අධ්‍යක්ෂ මගින් මා වෙත වාර්තා කරන ලෙස වැඩි දුරටත් දන්වමි.

ජේ.කේ.කේ.එම්.ආර්.එච්. කුමාරගම
ජ්‍යෙෂ්ඨ සහකාර ලේකම්

අ/ක.පී.බී.විජයරත්න
ලේකම්.
ප්‍රධාන හා අධ්‍යාපන අමාත්‍යාංශය
මධ්‍යම පළාත.

පිටපත් – 01. පළාත් අධ්‍යාපන අධ්‍යක්ෂ. (මප) – දැ.ස.
02. විදුහල්පති. මප/නු/ ශාන්ත සේවියර් විද්‍යාලය – දැ.ස.
03. විදුහල්පති. මප/නු/ පෙන්ටර් අනුස්මරණ විද්‍යාලය – දැ.ස.

Fig: 2 Central Provincial Ministry of Education



Atanban - Banjamin - Nanayakkara

R189/08

මගේ අංකය / My No. මප/අධ්‍යා/පාලා/16/34

ඔබේ අංකය / Your No.

කාර්යාලය / thupanyak. 081 - 2224041 / 081 - 2224042

ප. අ. ලේකම / P. D. E. 081 - 2225134

දිනය / Date. 2008.10.17

මධ්‍යම පළාත් සභාවේ අධ්‍යාපන දෙපාර්තමේන්තුව.

Education Department of Central Province

කලාප අධ්‍යාපන අධ්‍යක්ෂ,
අධ්‍යාපන කාර්යාලය,
නුවරඑළිය

විදුහල්පති අන්තර් පළාත් ස්ථාන මාරු.

උක්ත කරුණ සම්බන්ධයෙන් මධ්‍යම පළාත් අධ්‍යාපන අමාත්‍යාංශ ලේකම්ගේ අංක මපඅ/මපඅමස/ඊ/15/1/1/18 හා 2008.10.15 දිනැති ලිපිය හා බැඳේ.

2. ඒ අනුව මධ්‍යම පළාත් රාජ්‍ය සේවා කොමිෂන් සභා ලේකම්ගේ අංක මපස/පිඑස්ස/7/1බස්.ප හා 2008.10.06 දිනැති ලිපියෙන් මධ්‍යම පළාතට ස්ථාන මාරු කර ඇති බප/කැල/රාහුල කණිෂ්ඨ විදුහලේ විදුහල්පති එල්.වී.එස්.එස්.කේ.නානායක්කාර මහතා (ශ්‍රී.ලං.වි.සේ. 2-1) රාජ්‍ය සේවා කොමිෂන් සභාව විසින් සුදුසු ස්ථිර නිලධාරියකු පත්කරන තුරු පාසලේ කළමනාකරන කටයුතු විධිමත්ව පවත්වාගෙන යාම සඳහා එම කොමිෂන් සභාවේ ආවරණ අනුමැතියට යටත්ව ඔබේ නිර්දේශය හා ඔහුගේ ඉල්ලීම අනුව මප/නු/ශාන්ත සේවියර් විදුහලේ විදුහල්පති වශයෙන් ස්ථාන මාරු කිරීම අනුමත කර ඇත.

3. ඉහත අනුව අවශ්‍ය කටයුතු කරන ලෙස කාරුණිකව දන්වමි.

එච්.එම්. විජයසිරි හේරත්
මධ්‍යම පළාත් අධ්‍යාපන අධ්‍යක්ෂ

එච්. එම්. විජයසිරි හේරත්
මධ්‍යම පළාත් අධ්‍යාපන අධ්‍යක්ෂ,
පළාත් අධ්‍යාපන දෙපාර්තමේන්තුව,
මහනුවර.

පිටපත්.
1. ලේකම්, මධ්‍යම පළාත් අධ්‍යාපන අමාත්‍යාංශය - දැ.ගැ.
2. විදුහල්පති, මප/නු/ශාන්ත සේවියර් විදුහල - අවශ්‍ය ක.සඳහා.
3. විදුහල්පති, බප/කැල/රාහුල කණිෂ්ඨ විදුහල - අවශ්‍ය ක.සඳහා.
4. අතිරේක අධ්‍යාපන අධ්‍යක්ෂ මුදල් - අවශ්‍ය ක.සඳහා.
5. එල්.වී.එස්.එස්.කේ.නානායක්කාර මහතා - දැ.ගැ.

Fig: 3 : Central Provincial Ministry of Education

Analysis and Discussion

This study examined the conditions outlined in Education Ordinance No. 31 of 1939 regarding the appointment of heads to vested schools.

The following three cases provide evidence of deviation of the section 36 of the Ordinance 31 of 1939.

The school under review was established in 1859 and was vested in the state in 1960 under the Education Act No:5 of 1960 under Gazette No:12,998 [9].

Analysis and Discussion

No	Recommended by	Type of the School	Qualifications	From	Ref No	Cause for not being appointed	Final action taken by the victim	Action taken to rectify the situation	Result
Case 1	Proprietor	1AB	SLPS 11 BA-UOP Trained in Germany.	Western Province	R 025/09	Unknown	Transferred back to Colombo.	The Educational authorities and the proprietor were informed by the parents and the Past pupils.	Failure
Case 2	Proprietor	1AB	SLPS 1 M.Ed,	Western Province	R298/16	Unknown	Transferred back to Colombo.	The Educational authorities and the proprietor were informed by the parents and the Past pupils.	Failure
Case 3	Proprietor	1AB	SLPS 111, Trd.T.	Central Province	R189/08	Unknown	Remained in the same school	The Educational authorities and the proprietor were informed by the parents and the Past pupils.	Failure

Table 1 : Details of Principals appointed

Case 1: Individual No: 01 was appointed to the Academic Staff of a 1AB School in the Central Province following all standard precedures; he held the SLPC Grade 11 qualification with a Bachelor's Degree from the University of Peradeniya, trained in Germany. He was recommended by proprietor of the College, as per section 36 of Ordinance No: 31 of 1939. He states (2011) that he was not even provided with a timetable to teach, and was not allowed to carry out religious activities at the College. Records reveal that he was given a transfer to leave the College in 1999 [10].

In the second case, responding to the recommendation of the proprietor and following all standard procedures, the second individual was issued with an appointment letter dated 26th October 2008 by the Central provincial secretary to the Ministry of Education. Records reveal that he was forced to sign his attendance at the Zonal Director's office instead of making allowance to assume duty as the Principal of the College. Despite having vacancies in the district, he was later transferred back to Colombo.

The Individual No: 3 was appointed Principal of the College in 2016, However, his assumption of duty as principal was later annulled. His name had been recommended by the proprietor of the school, in accordance with Ordinance No. 31 of 1939.

The above three transfers to Nuwara Eliya from the Capital City Colombo and Nuwara Eliya were possible through the continuous hardwork of the OBA and parents with the intervention of the proprietor. All appointments were made possible through direct mediation of the divisional directors, zonal directors of the respective education zones, provincial directors, and provincial secretaries with the approval of the public services commissions of the Central and the Western Provinces. The study of correspondence and focus group discussions show that there had been no political influence used in the effort of obtaining the transfers. The refusal of appointments has caused deprivation among the parents and the students who have lost many opportunities of being guided by experienced Principals who have had better exposure to the system working in leading schools in the Capital city.

Student Population	Level of School		Type of Schools				Total	%
	National	Provincial	1AB	1C	Type 2	Type 3		
1-50	1	1472			140	1333	1473	14.5
51-100		1571		34	556	981	1571	15.5
101-200		2160	7	200	1188	765	2160	21.2
201-500	12	2663	107	886	1144	538	2675	26.3
501-1000	59	1278	254	643	154	286	1337	13.2
1001-1500	67	326	199	134	23	37	393	3.9
1501-2000	70	146	163	38	9	6	216	2.1
2001-3000	106	93	178	16	5		199	2.0
3001-4000	49	19	66		2		68	0.7
Above 4000	32	2	34				34	0.3

Table 2: Government Schools by Type and size of student population.
Source: Schools senses 2022

The table above illustrates the variation in parents' preferences when selecting schools for their children, which is influenced by several factors, including the calibre of the leadership of the school.

The current Ministry of Education in Sri Lanka continues to follow the Ordinance No. 31 of 1939, and its provisions remain valid. Furthermore, Act No. 5 of 1960 reaffirms the rights of the proprietor as outlined in Ordinance No. 31 of 1939.

Conclusion

It was revealed that the hindrance caused in appointing qualified individuals to administer the institution under review is clear through evidence. Though the appointments were made following all standard procedures by the relevant authorities without any political influence, the assuming of duty had been interrupted and the reasons are unknown.

Political interferences in the appointment of teachers and heads to schools in Sri Lanka causes hindrance to the smooth functioning of institutions causing many issues.

Recommendation

To adhere to the Education Ordinance and Acts and cause. justice, equivalance and equity.

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Assessing the Efficacy of Educational Acts Past Pupils' Contributions towards Extra-Curricular Activities in Schools

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Abstract

Extra-curricular and co- curricular activities have been a part of education since the inception of education. This paper delves into the effectiveness of Circulars No:5 of 1960 and Circular No:27 of 1964 in achieving their intended goals. Specifically, it investigates the encouragement and directions the Circulars provide towards the past pupils of Sri Lankan schools in carrying out extra -curricular activities for the benefit of the students. The research employs a mixed-methods approach, combining quantitative analysis of contribution data with qualitative interviews to gain insights into the impact of these circulars on past pupils' engagement. Findings suggest a varied degree of success in achieving the circulars' goals, with implications for policy and future engagement strategies.

Keywords

Extra-curricular activities, Circulars, Alumni Engagement, Educational Policy

Introduction

Apart from the Education Ordinance of 31 of 1939, Act No 5 of 1960 and 8 of 1961 that guide the education system in Sri Lanka.

The Circular No. 27 of 1964 provides more authority to the Head of the institution and acknowledges the support and guidance provided by PPA and aims to solidify the bond between the school and its alumni while inviting the members to adhere to the conditions in fulfilling the roles and responsibilities. The circular states that the school's activities encompass a wide range of initiatives aimed at enhancing the overall experience and well-being of the students. While the circular lays out positive objectives and conditions, the effectiveness in achieving these goals remains a subject of inquiry.

Literature Review

Angela W. Little (2010) presents the following table.

Number of schools	Number of teachers
123 schools	One teacher
320 schools	Two teachers
1553 schools	With less than 50 students

Further, the statistics of the MOE shows that 50% of Sri Lankan schools have less than 200 students. Commenting on the present education system Eric de Silva refers to Harsha Aturupane (2013) stating " that the real answer is to encourage schools that run as civil society organisations with endowment funds and good school management boards.

Prof. J.N.O. Fernando (2005) adds " It is quite clear that politicization of our school system, which commenced with the take-over of schools in the early sixties, has increased

exponentially by leaps and bounds over the past four decades; and stresses that the much-abused word "Education Reforms" simply will not do! "

The above three references show that there is a reversion in the Sri Lankan education system. As a remedy, the involvement and assistance of past pupils has become an essential obligation.

Previous studies on past pupils' contributions have highlighted their significance in enhancing educational, extra -curricular and co -curricular activities in schools.

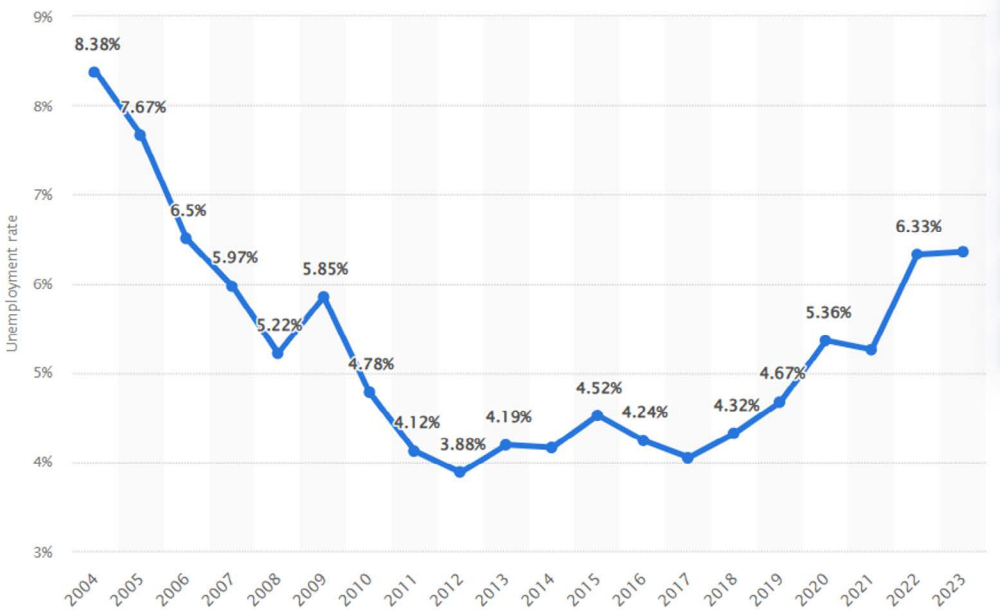
Importance of Extra Curricular Activities

Studies have confirmed relationships between participation in extra-curricular activities and employer desired skills such as communication and team-work (Clark et al., 2015), Problem solving (Larson et al, 2006) and self-motivation although establishing definitive causation is difficult in these contexts.

Clark et al. (2015) note that it is difficult to assign relative credit between structured academic programmes and extra-curricular activities in developing these skills

In Sri Lankan context it is evident that the tertiary level students lack personality development and soft skills due to their non participation in extra -curricular activities during their primary and secondary level education. This void has resulted in creating imbalanced characters who have become unsuccessful in their employment and in the society. Gallo, 2012 mentions that these trends present significant challenges to traditionally structured institutions. Larger batches of students mean fewer support for students and difficult transitions from earlier education. They can lead to negative effects at both the individual (alienation, lack of motivation, lack of social engagement) and institutional level (high drop-out rates). The focus on economic outcomes mandates that institutions be responsive in providing students with the skills that are demanded by future employers.

Institutions seek to build positive relationships with alumni, in the hope of future donations, but also to receive other benefits such as institutional advocacy, participation in institutional governance and acting as an institutional ambassador.



Graph No 1- Sri Lanka: Unemployment rate from 2004-2023

The above depicts the unemployment rate in Sri Lanka according to Aaron O'Neill, Nov 21, 2024

Greenbank (2015) suggests that job applicants can use extra-curricular activities to demonstrate that they possess qualities that employers desire. Extra-curricular activities can be documented as part of a portfolio.

The best lesson a student can learn through sports is to be modest in victory and to be generous in defeat while qualifying himself/herself to get employed accordingly.

Past Pupils Engagement in Extra Curricular Activities

Engaging past pupils in school activities enhances financial support, mentorship opportunities, and a stronger sense of community. The Act No. 5 of 1960, No.8 of 1961 and Circular No. 27 of 1964 have been implemented in various educational settings, with mixed results.

Gunaratne N.H. (1985) states "Many schools in Ceylon have had to depend for their existence on money brought from abroad. St Thomas' College has had very little foreign aid and the generosity shown by Old Boys to St. Thomas' was magnanimous.

Gunaratne, N.H. (1985) mentions that it is not a frail thread on which Old Boys annually rest in their friendship. Warden Stone (1926) states "Live for St.Thomas', do anything for her whenever you are asked to do it, if necessary die for her" it is a third of a century since those words were spoken.

During an interview, a participant mentioned that the Past pupils' endeavor of setting up learning Management System (LMS) in his school in Colombo in 2018 was taken up as a timely positive move by all as the system had served the purpose during the sudden Lockdown in 2020 where 3575 classes were conducted virtually.

A past pupil, Alegius G.Pillai from Canada (2010) ends his letter to the OBA with the following lines." I owe my life to my dear parents and second only to them, I owe a debt of gratitude to my beloved Alma Mater for what I am today". This well depicts his loyalty towards the College.

These PPAs have been doing yeomen service to their Alma Mater. Providing infrastructure facilities, handling sports activities, providing scholarships and financial assistance, teacher training workshops, promoting music and drama are to name a few projects successfully launched by the past pupils of different institutions over the years.

During the focus group discussions, one of the former Secretaries of an OBA in Nuwara Eliya stated that the Principal of the school has taken the OBA as a threat to his administration and OBA is not allowed within the school.

Findings of the study that involved several PPAs in the Western, Uva and Central Province reveal that the interference of the Heads of schools has caused negative impact on the aspirations and the good services rendered by past pupils.

St. Sebastian's College
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09th January, 2025

Mr. Suneth Fernando
The President,
Old Boys' Association - St. Sebastian's College,
Moratuwa.

Dear Mr. Suneth,

Invitation to the College Loyalty Day

It is with great pleasure that I invite all batch presidents of the Old Boys' Association to participate in the College Loyalty Day 2025, which will be held on Friday, 24th January 2025, at the College.

This year's Loyalty Day holds special significance as it coincides with two landmark events:

1. The 40th Anniversary of the College Senior Cadets' Platoon.
2. The declaration of the preparations of the 175th Jubilee Year.

The detailed program of the day's events will be communicated to you in due course. Kindly note that all attendees are required to wear a full suit along with the Old Boys' tie as a mark of respect and tradition.

We kindly request you to confirm the participation of the attendance of the respective batch presidents, on or before Thursday, 16th January 2025. Your support will be invaluable in making this occasion a memorable one.

Thank you for your dedication and contribution to your alma mater. We look forward to your positive response.

Sincerely,

.....
Rev. Fr. Daya Dharshana Perera
RECTOR / PRINCIPAL

Rev. Fr. Daya Dharshana Perera
Rector / Principal
St. Sebastian's College,
Uyana, Moratuwa.

However, the above letter (2025) from St Sebastian's College, Moratuwa (Est.1854) depicts the recognition of the assistance of old boys.

Methodology

Primary data were gathered through focus group discussions and interviews with past pupils from 1AB and 1C schools in the Western, Uva and Central provinces. The sample includes Government Schools, Semi-Government schools and Government approved Private schools. According to the focus group discussions that were carried out, the voluntary services of the past pupils are not encouraged by certain administrators of schools citing clauses in the circulars issued by the educational authorities.

Discussion

Answering to a question, the joint secretries of St Xavier's OBA (Est 1947) stated that the involvement of the Past Pupils in school extra-curricular activities should not be hindered. It is very important at a juncture where there is a shortage of teachers prevalent in the Sri Lankan education system and the economy of the country is in chaos. He added " this will bring many benefits; past pupils who have excelled in sports, music, English language skills, career guidance and entrepreneurs can be utilised to enlighten the present students.

Jt.Secretaries of SXCOBA, 2024 mention in a letter that " through perseverance and dedicated efforts, our members succeeded in securing the appointment of an Old Boy as the principal of our institution in 2023. In 1998, 2008, and 2016, regrettably, three appointments were hindered due to the lack of support from educational authorities". They further add that the Old Boys Association of St Xavier's College has carried out voluntary projects from October 2023 to Dec 2024 investing more than Rs. 4.5 Million;

According to the focus group discussions the researcher had with past pupils, some of the participants were not in favour of the circular No:27 of 1964. According to them certain schools have created a greater distance between the past pupils and the school using this circular depriving the students of productive extra-curricular activities and co-curricular activities, increasing the burden on parents and teachers.

The participants questioned whether all current schools have established their own alumni associations in compliance with the Circular No:27 of 1964.

Conclusion

According to the focus group discussions that were carried out and the review of literature show that past pupils have served their Alma Mater in implementing valuable projects while Past pupils have tirelessly worked towards securing the appointment of teachers and principals to guide the destinies of their school. In certain cases, the voluntary services of the past pupils are turned down or discouraged by certain administrators of schools citing the circular No 27 of 1964 depriving both the present and past students.

Further Research

1. Have all current schools established their own alumni associations in compliance with Circular No:27 of 1964.
2. Why do some Past Pupils' Associations choose to have one of their members as President instead of appointing the Principal to this role?
3. What positive impact have the Past Pupils' Associations, with Principals appointed as Presidents, brought about?

Recommendations

The following is recommended to mitigate the issue;

- To Obtain the services of the past pupils in a professional and amicable manner
- To revise the circular permitting the PPA to function independently while building up a better rapport with the administration of the school
- To train the principals and teachers to work with the past pupils.
- To encourage many Past Pupils' Batches to be formed under different committees

and to obtain services effectively and amicably.

The Principal/Head of the institutions to be the patron of All Past pupils' bodies to provide advice and guidance and monitor the financial aspects.

- To maintain transparency in financial transactions.
- To recognize the generous services of the past pupils.

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Psychosocial Impact of the Economic Crisis on the Education of Children in Kaka Munai Village in Kinniya, Sri Lanka.

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Abstract

Soon after the Covid-19 pandemic, Sri Lanka had to go through a difficult period due to the economic crisis affecting all aspects of life, such as economic, educational, social, and psychological. The economy contracted 3.6% in 2020 and shrank by 16.4% leading to an economic frustration among multiple sectors, making the rural agrarian, fisheries, and plantation communities more vulnerable. As a nation, there were several welfare programs implemented; however, the adequacy effectiveness and productivity of such initiatives to enhance quality of life of people is rather questionable. Need arises for an in-depth qualitative study to critically assess existing living conditions, psycho-social impact of the economic crisis, on rural marginalized fisheries communities in Sri Lanka. The objective of the study is to micro focus on the education sector within the above-mentioned broad framework. An empirical understanding of psycho-social lifestyle of Kaka Munai community, Kinniya division of Trincomalee district was essential. There are 85 families living in the selected area. Adolescents aged 14 to 17 years and their parents were randomly selected as the sample for this study. Qualitative data collection and survey methods incorporated as data collecting methodology. Structured interviews, semi- structured interviews, separate focus group interviews with students and parents, were conducted to gather their perspectives and experiences. As a result of fuel shortage, fishermen couldn't go fishing, and it led to a state of unemployment and underemployment in the community. Loss of regular income sources and rapid increase of cost of living push them into poverty. As they are unable to meet their basic needs appropriately, especially affording the food items, sudden malnutrition in children rose in the community. Parallelly, there was a significant drop in school attendance, and the perspective of education changed among the young generation. Also, many a crisis had arisen psychologically and socially due to economic crisis. Due to unemployment and unexpected changes in employment sectors, many people are affected psychologically. Families lost their incomes and fell into financial traps. Therefore, Sri Lanka must review their existing national economic and social policy and consider introducing new policies that can address such issues directly.

Introduction

Education in Sri Lanka is crucial for the country's culture and life, since British Empire's Christian missionary system establishing it in 19th century. Government provides free education from ages 5 to 14, with free printed books and uniforms. However, economic crisis has disproportionately affected children from socioeconomically disadvantaged or marginalized backgrounds, with the poorest students experiencing 57% more learning loss than their more prosperous counterparts. This paper aims to explore the psycho-social consequences of the economic crisis on education and mental well-being of adolescents from Kaka Munai in Kinniya.

Research Problem

The pursuing economic crisis has had an enormous effect on many parts of society, with adolescents being especially vulnerable. However, there is a lack of empirical

evidence on how these economic stressors affect the psychological circumstances and future aspirations of the teenagers. This information gap restricts the creation of effective interventions and support systems. Understanding these dynamics is critical for educators, parliamentarians, and mental health professionals working to reduce the negative consequences of economic uncertainty on young people.

Key Research Problem Elements and Questions

1. Economic Crisis Impact: Evaluate how the economic slump is influencing teenagers' attitudes on schooling, aspirations for professional objectives, and work chances.
2. Educational Concerns: Evaluate specific psychological implications on school education and motivation.
3. Future Aspirations: Investigate attitudes toward the future, career possibilities, and work opportunities.
4. Psychological Factors: What psychological supports and coping techniques are available to help people deal with the effects of the economic crisis?
5. Contextual Focus: How to develop a community-based psycho-social support mechanism to help children and adolescents cope with the psycho-social consequences of the economic crisis.

Methodology

Field of study:
Kaka Munai, Kinniya, is a lovely village famous for its thriving fishing and lagoon prawn -catching operations. The area has abundant oyster beds, corn and peanut plantations, and brinjal crops. The settlement has a sandy floor and is frequently washed by hot gusts, producing a distinct and lovely atmosphere. Kaka Munai is popular for its natural beauty and agricultural wealth.

The study population and data collection:
Fishing and associated jobs provide most of the villages an income. There are 85 families, 70 of which have children. 22 families have children aged 14 to 18 years.

Research Method:
This qualitative study explored the experiences and perceptions of children and parents in Kinniya, Sri Lanka, focusing on education, the economic crisis, family values, prospects, and economic independence. Data was collected using structured and semi-structured interviews, focus group discussions, and key informant interviews. Convenience sampling was used to identify participants, with oral parental consent obtained for child interviews. The study included 22 randomly selected pupils (12 boys, 10 girls; 17 Muslims, 5 Hindus) and involved a three-day field trip. Key informant interviews were conducted with the Divisional Secretary of Kinniya and Mrs. Fareeda, a local representative, to examine village dynamics, challenges, and support systems. In total, 37 participants, including children aged 14 -18 and their parents, shared their insights, highlighting systemic gaps and the importance of education and job security. Focus group discussions were held in Tamil to gather diverse perspectives.

Data Analysis:
Analysis methods such as Thematic analysis, Content Analysis, Narrative Analysis, Grounded Theory, Framework Analysis and Comparative Analysis will be used as appropriate.

Ethical consideration:
This study, conducted in Sri Lanka, focused on the psycho-social impact of children and the importance of avoiding harm. Ethical considerations included informed consent, confidentiality, minimizing harm, respecting cultural norms, beneficence, non-maleficence, equity, community engagement, and transparency. The study aimed to provide insights for suitable interventions, avoid harm, and ensure participants were not harmed.

Literature Review

COVID-19, poor economic and agricultural decisions, a corrupt government and the Ukraine war have resulted in an acute economic crisis in Sri Lanka. Over 6.2 million people, including 2.9 million children, urgently need humanitarian assistance. The education sector has been hit hard, with children facing a triple threat — learning loss, poor nutrition and challenges to well-being. School closures during COVID-19 and repeated closures in 2022 from fuel shortages due to economic crisis have robbed a generation of children of their right to education for nearly two years. (East Asia Forum, 2023)

The pandemic disrupted the learning of 4.8 million children in Sri Lanka; a lack of fuel continues to keep children and teachers out of the classroom. On July 3, 2022, school closures were extended for yet another week due to a nationwide fuel shortage. “My school in Colombo had to close before the end of the term,” said 17-year-old Jithmini, above. “I was not able to go to school because there was no fuel. I am worried about what will happen next. I just need fuel for my school van.” (UNICEF USA, 2022)

United Nations (2022) states that, Consequently, parents’ heightened stress levels negatively affect their ability to support their children’s education and emotional well-being. Although Sri Lanka’s economic crisis is leading to a significant rise in mental health issues. Financial difficulties during economic crises exacerbates family conflicts and diminishes emotional support for adolescents, impacting their mental health (Conger et al., 2010) with that, parental unemployment, income reduction, and weakened social support networks have increased depression among Sri Lankan adolescents, fostering hopelessness and worsening mental health concerns (Fernando & Wickramasinghe, 2022). Adolescents face a bleak outlook on employment prospects and financial independence, leading to increased levels of stress and depression (World Bank, 2022).

Additionally, the shift to remote learning during COVID-19 pandemic widened educational inequalities, as many lacked accesses to necessary resources (World Bank, 2022). These challenges have heightened anxiety, impairing cognitive functions such as attention and memory, which negatively affect academic performance (Owens et al., 2012). Restricted access to community spaces or activities further isolates adolescents, increasing their vulnerability to exclusion from their peer groups (Reiss, 2013).

Adolescents from low-income families experience bullying and exclusion as they are stigmatized for their financial difficulties. Social stratification amplifies feelings of shame and lowers self-esteem among economically disadvantaged adolescents (Reiss, 2013). Overall, the economic crisis has significantly affected adolescents’ mental health and academic performance, with anxiety, depression, and educational challenges becoming prevalent.

Key findings

A study conducted in Kinniya, Trincomalee, surveyed 85 families, including 22 with adolescent children, to assess the impact of the economic crisis on the community. Key informants highlighted challenges in livelihood, health, education, and family relations, with significant impacts on adolescents’ well-being. Inflation and rising school expenses

have made meals and education less affordable, contributing to increased school dropouts. Nearly half of the adolescents interviewed had dropped out of school, with financial issues cited as the main reason. Factors such as travel costs, lack of tuition affordability, and transportation barriers further hinder access to education.

Adolescents face challenges in maintaining school attendance due to teacher support shortages, discrimination, and financial constraints. High teacher turnover, distance, and cultural clashes also contribute to these difficulties. Parents express concerns about the lack of vocational training and difficulties during Covid-19. Perceptions of education vary, with some seeing it as essential for success, while others view it as unaffordable due to the crisis. Many adolescents are drawn to work for quick money, despite parental guidance to stay in school.

Despite these challenges, adolescents remain optimistic about their future, though they feel limited by their circumstances. Psychological issues, such as fear and distress, are prevalent among them. Addressing these issues is crucial for improving education and support for adolescents in rural areas.

Adolescents in impoverished communities like Kaka Munai face educational and psychological challenges due to economic instability, strained social dynamics, and lack of support. Psychological theories highlight how financial stress, insecurity, and community hardships hinder academic performance, motivation, and personal growth. These issues emphasize the need for systemic and community interventions to support adolescent.

Conclusion

Sri Lanka's economic crisis has severely impacted Kaka Munai, worsening health, education, and livelihoods. Inflation has made food and medication unaffordable, increasing financial distress and school dropout rates, with 45% of adolescents leaving school due to costs. High living expenses, lack of transport, and discrimination further hinder education, costly maintenance expenses, and cultural confrontations between teachers and students worsen the problem, while limited job prospects discourage youth. Parental concerns and their inability to provide for their children heighten the situation. Many face stress, fear, and social issues like substance abuse and inadequate protection for girls. With minimal support from mosques and NGOs, urgent interventions are needed, including financial aid, psychosocial support, and better government policies to break the cycle of poverty.

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An Exploratory study on the measures that can be taken to reduce the problems faced by Ordinary Level students in Sinhala literary criticism.

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Abstract

The field of education plays an indispensable role in shaping the future of any country, and Sri Lanka is no exception. Within the Sri Lankan educational system, Ordinary Level (O/L) education marks a critical stage in a student's academic journey, with the Sinhala subject, particularly literature and entertainment, holding significant value. For many students, this represents a transition into new academic territory, often accompanied by challenges in understanding and engagement. This study specifically focuses on the difficulties encountered by students in mastering the Sinhala literature component at the O/L level. The research was conducted in three schools situated in the Kandy district: Rasindev Vidyalaya, Peradeniya Wimaladharmasuriya Vidyalaya, and Hidagala Siwali Maha Vidyalaya. These institutions, each with its own unique cultural context, provided a diverse backdrop for exploring the issues faced by students. To gather comprehensive data, information was collected from Sinhala literature teachers as well as over fifty students from each school. This was done through a combination of interviews, group discussions, oral questionnaires, and classroom observations. The findings of this study highlighted a number of persistent challenges in Sinhala literary education. A key issue identified was the unfamiliarity students face when transitioning from junior secondary education to more complex topics in Sinhala literature. Furthermore, the study revealed shortcomings in teaching methods, which often fail to foster deep understanding and engagement. Many students struggled with grasping the material due to the challenging nature of the content, while others exhibited weak critical thinking skills, resulting in limited engagement with the subject. Moreover, students often displayed a lack of interest, primarily due to their previous ignorance or inadequate exposure to literary criticism. The difficulty in recalling stories and events from the literature, combined with lower performance in literary critique assessments, further exacerbated the problem. In response to these challenges, the research proposes a set of pedagogical strategies aimed at improving the teaching and learning of Sinhala literary criticism. These strategies include simplifying complex concepts using memorable, relatable examples, incorporating frequent writing exercises to enhance both writing and critical thinking skills, and integrating audio-visual aids to make lessons more dynamic and engaging. Additionally, the study suggests that instruction should be more tailored to the cognitive development levels of the students, ensuring that the material is accessible and stimulating. By adopting these innovative teaching methods, it is anticipated that students' comprehension and critical analysis of literature will improve, enabling them to better navigate the complexities of literary criticism and perform more successfully in assessments.Ultimately, this approach seeks to cultivate a deeper understanding of Sinhala literature among students, equipping them with the necessary skills to become insightful and effective literary critics. Enhancing teaching methods can improve O/L students' engagement and performance in Sinhala literary criticism. Through these changes, the study aims to contribute to the enhancement of Sinhala literature education at the O/L level, addressing the current challenges and fostering a more robust and engaging learning experience.

Keywords

Junior secondary section, literary criticism, Ordinary level students, Problems, Sinhala literary entertainment

A study on the importance of providing professional opportunities for greater productivity in the A-Level learning and teaching process. Based on Kandy Districts

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Abstract

Education is widely recognized as a powerful tool for societal change, and the education sector plays an indispensable role in the development of any country. In Sri Lanka, the higher education system, particularly the A-Level stage, is considered a pivotal phase for students aspiring to enter the workforce. The A-Level sector provides students with the foundational knowledge and qualifications needed to pursue higher education or gain employment. However, a significant challenge remains, as many students struggle to transition from the completion of their A-Levels into permanent, sustainable employment. This research seeks to explore ways to develop an education system that not only aids students in academic achievement but also equips them with the necessary skills and resources to enter the job market successfully after their A-Levels. To gather insights into the challenges faced by students in the Kandy district, four schools with distinct cultural backgrounds were selected for this study. The sample consisted of eighty A-Level students and twenty teachers. Data was collected through various methods, including oral questionnaires, interviews, classroom observations, and an analysis of student progress reports. The findings highlighted several significant issues within the current education system. A notable concern was that many students struggled with the teaching and learning processes, often resulting in poor academic performance. Additionally, absenteeism and limited participation in extracurricular tutoring programs were observed. A number of students chose to take on part-time jobs instead of fully engaging in their studies, further hindering their educational progress. Moreover, students faced difficulties in certain subjects, especially when their interests and talents did not align with the available course offerings. Several solutions emerged from discussions with students, who expressed a strong desire for more career-oriented guidance. Students highlighted the need for information on various career fields, which would help them make informed decisions about their futures. The study also suggested integrating more practical lessons alongside theoretical knowledge to better prepare students for real-world challenges. Career counseling services were deemed essential, as these would assist students in identifying their strengths and aligning them with potential job opportunities. Additionally, there was a clear call for improving access to Information and Communication Technology (ICT), which could open doors to diverse career pathways. For students who struggled with theoretical learning, it was suggested that assessments could focus on practical skills, offering them alternative ways to demonstrate their abilities. Finally, the study proposed that the government increase support for local job opportunities, providing students with more chances to secure permanent employment after completing their A-Levels. In conclusion, by incorporating career-focused knowledge, practical skills, and enhanced support systems into the education framework, students can be better prepared for permanent employment. This approach would not only help reduce the number of students who fail A-Level exams or are unable to gain university admission, but it would also contribute to a stronger, more

skilled workforce, benefiting both students and society as a whole. Overall, this research helps improve the transition from education to employment.

Key words

Advanced Level education, learning and teaching process, permanent employment, vocational education opportunities, vocational counseling.

An exploratory study of university students' perceptions of the impact of sports activities on mental health: A study based at the University of Peradeniya

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Abstract

This exploratory study was conducted at the University of Peradeniya, Sri Lanka, to determine the impact of sports activities on students' mental health. Given the significant academic pressure, university students often suffer from stress, anxiety, and depression. This research looks at the role of sports in alleviating some of these mental health issues and thereby the overall well-being of students. The primary objective of the study is to assess how sports affect students' mental health in terms of stress, anxiety, depression, and emotional well-being. The study will then attempt to identify the benefits of sports participation as perceived by students and learn about the barriers to such participation. The study will also attempt to explore the promotion of sports as a mechanism for improving mental health. A mixed methods research design was used, and extensive data was collected from both quantitative surveys and interviews in qualitative settings. The study sample included 300 students from various academic disciplines, equally represented by gender and academic year. In-depth interviews were conducted with an additional selection of 20 students. The survey focused on the frequency of engagement in sports activities (how often), types of sports played and the perceived role of sports in terms of mental health benefits. Statements about the positive impact of sports on mental health were rated on Likert scales. The results showed that 65% of students participated in sports regularly, 50% at least once a week and 15% daily. The main sports played included cricket, volleyball, badminton and running, with team sports often preferred for their social interaction rewards. Around 85% of students said that sports had a positive impact on their mental health. The most common benefits were stress relief (70%), better mood (60%) and reduced anxiety (55%). Many students said that sports helped them relax and forget about the stress of university life. Interviews provided greater insight, with students indicating that team sports gave them a sense of belonging and increased their emotional well-being. Despite these positives, the study found several factors that prevented students from playing sports. These included not having enough time due to university work (65%), not being able to access sports facilities (40%) and physical limitations (30%). Some students felt uncomfortable or self-conscious about getting involved if they were not confident in their skills or were new to certain sports. To make things better, students suggested improving sports facilities, offering a more diverse sports program for different skill levels and adding mental health support to sports activities. The results show that sport helps with mental health, and it is important to address issues such as time constraints and access to facilities to engage more students. Social interaction through team sports plays a big role in promoting good mental health by combating feelings of loneliness. The research suggests that the University of Peradeniya should invest in better sports facilities, develop sports events that are accessible to all, and support students who are not interested in exercise. By making sport a bigger part of mental health plans, the university can create healthier and more balanced lives for students. Future studies could look at how sport affects mental

health over time. The specific psychological effects of different sports and how culture and university life can change the way students think about and experience sports and mental health.

Research Problem

Sports activities, Mental health, University students, Stress relief, Barriers to participation.

The Impacts of Domestic Violence on Children

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Abstract

Domestic violence, also known as intimate partner violence, is a widespread problem in society that impacts people of all ages, genders, ethnicities, and socioeconomic backgrounds. A variety of abusive actions, including financial, emotional, sexual, psychological, and physical ones, are used to control or dominate a partner. Domestic violence has serious and long-lasting effects on victims, but it has an especially negative effect on children who witness or are subjected to such abuse. PTSD, anxiety, despair, aggression, and scholastic difficulties are just a few of the psychological, emotional, cognitive, and behavioral issues that have been connected to childhood exposure to domestic abuse. The aforementioned impacts may endure into adulthood, impacting a child's capacity to establish sound interpersonal bonds, achieve academic success, and preserve emotional stability. Research indicates that children exposed to domestic violence are at greater risk of developing a maladaptive coping mechanism, such as substance abuse, self-harming behaviors or engaging in violent behavior by themselves. The severity of these effects varies based on factors such as the duration and intensity of the exposure, individual resilience, family factors, and the availability of social support networks. Moreover, children who experience domestic violence together with other adverse childhood experiences—such as neglect, parental substance abuse, or poverty—face compounded risks that further impede their development and well-being. Even with increasing awareness of the problem, there are still unresolved issues about the long- term behavioral and psychological effects of having been exposed to domestic violence as a child. According to existing studies, interventions that emphasize family counseling, early psychological support, and community- based protective measures to reduce some of the negative impacts. More thorough studies on successful intervention techniques, the creation of laws, and support networks targeted to affected kids remain needed, thought. This secondary review aims to integrate current research on the impacts of domestic violence on children, with a focus on mental health, cognitive development, social interactions, and behavioral outcomes. This review aims to provide a more in-depth understanding of the complex impact of domestic violence on young people through reviewing existing studies and highlighting essential areas for future research and policy development. Addressing this issue is critical for breaking the cycle of violence and protecting the welfare of future generations.

Literature Review

Impacts of Domestic Violence on Children

Domestic violence is a pervasive issue that affects individuals, families, and even the whole communities worldwide. Its impact extends beyond the immediate victims, influencing the psychological, emotional, and social development of children who are exposed to domestic violence. Research indicates that children living in households with domestic violence are at higher risk of experiencing emotional, psychological, physical, social and behavioral problems, which can persist into adulthood. This literature review explores the prevalence, immediate and long- term consequences, and inter-generational cycle of domestic violence, drawing upon key studies and meta-analyses.

Prevalence of Domestic Violence Exposure in Children

Children are highly vulnerable to domestic violence, whether they experience it directly or

indirectly witnessing it. Exposure to violence during developmental years can significantly impact a child's emotional well-being, cognitive abilities, and overall life trajectory. Studies estimate that nearly two-thirds of children globally have experienced violent discipline within the past year, highlighting the widespread nature of this issue (Hillis et al., 2016). Domestic violence does not discriminate based on socioeconomic status, affecting children in low-, middle-, and high-income families alike.

Immediate Effects of Domestic Violence on Children

Exposure to domestic violence has significant immediate psychological and behavioral consequences for children, which vary depending on age and developmental stage. Infants may exhibit decreased responsiveness, fussiness, and disrupted eating or disturbed sleeping patterns. Preschoolers often display behavioral issues, such as fighting and tantrums, aggression, frequent bedwetting, and social withdrawal. Secondary and upper-school children may experience poor academic performance, emotional detachment, and difficulty forming peer relationships. Adolescents exposed to domestic violence are more likely to engage in risky behaviors, including substance use, early sexual activity, and delinquency. These early-life stressors can contribute to long-term mental health challenges if left unaddressed (Fry et al., 2018; Holt et al., 2008; Maguire et al., 2015; Romano et al., 2015).

Educational Consequences of Domestic Violence

Academic success plays a crucial role in shaping a child's self-concept and future opportunities. Research suggests that children exposed to domestic violence struggle a lot in school due to emotional distress, concentration difficulties, and cognitive impairments. Studies show that these children are at greater risk of experiencing learning problems, leading to lower grades, grade repetition, and special education placement (Fry et al., 2018; Holt et al., 2008; Maguire et al., 2015; Romano et al., 2015). In many cases, the trauma associated with domestic violence disrupts cognitive processes such as memory retention, attention flexibility, and problem-solving skills, further hindering academic performance.

Psychological and Behavioral Effects of Domestic Violence

Children who have experienced domestic violence often show deficits in cognitive and emotional regulation, which affect their ability to form healthy relationships and cope with stress. These impairments contribute to anxiety, depression, aggression, hyperactivity, and social withdrawal (Fry et al., 2018; Holt et al., 2008; Maguire et al., 2015; Romano et al., 2015). Maltreated children may struggle with self-regulation, display impulsivity, and have difficulty adhering to social norms. Additionally, they may internalize violent behaviors, either becoming aggressive themselves or developing a passive acceptance of abuse in future relationships.

Impact on Parenting and Child Development

The quality of parenting in households affected by domestic violence is often compromised. Research suggests that maternal stress and depression—common among abused women—result in emotional unavailability, neglect, and, in some cases, abusive parenting. Women who experience violence are more likely to suffer from post-traumatic stress disorder (PTSD), anxiety, depression, and low self-esteem, all of which negatively impact their ability to provide stable and nurturing care to their children (Levendosky, Lynch, & Graham-Bermann, 2000).

Studies indicate that domestic violence can lead to intergenerational aggression, where children who witness abuse may later exhibit violent behaviors toward their own parents or siblings. Adolescents in abusive households are 18 times more likely to exhibit physical aggression toward their parents (Jackson, 2003; Ulman & Straus, 2003). The Sequential

Perpetrator Model suggests that battered mothers may unintentionally direct aggression toward their children, further perpetuating cycles of abuse (Coohey, 2004). Additionally, Holden et al. (1998) argue that children in violent households may suffer from "secondary victimization," in which they endure both direct abuse and indirect harm from witnessing parental violence.

Long-Term Consequences and the Intergenerational Cycle of Domestic Violence
The effects of domestic violence often persist into adulthood, shaping the way individuals form relationships, regulate emotions, and engage with society. Children who grow up in violent households are more likely to struggle with interpersonal relationships, exhibit aggressive tendencies, or develop substance use disorders. Studies indicate that without proper intervention, exposure to domestic violence can perpetuate a cycle of abuse across generations (Lundy & Grossman, 2005).

Additionally, long-term exposure to domestic violence has been linked to increased risks of PTSD, anxiety disorders, depression, obesity, diabetes, and substance abuse (Buchbinder, 2004; Holdenet al., 1998). These adverse childhood experiences contribute to social exclusion, incarceration, homelessness, and economic instability in adulthood. The complex relationship between domestic violence and childhood adversity underscores the need for early intervention and comprehensive support systems (Etherington & Baker, 2018).

Conclusion
The literature constantly shows that domestic abuse has a permanent impact on children, impacting their psychological, emotional, and learning abilities. While the immediate consequences, such as anxiety, anger, and learning difficulties, are obvious, the long-term impacts, including mental health illnesses and perpetuated patterns of abuse, provide significant societal challenges. Effective solutions required a multidisciplinary strategy, which includes parental support programs, based on trauma- education, and community-based activities to break the cycle of violence. Addressing domestic violence at the family and social levels is essential to ensuring future generations' well- being.

Methodology

This secondary review employs a qualitative approach to integrate existing literature on the impacts of domestic violence on children, focusing on mental health, cognitive development, social relationships, and behavioral outcomes. Data was collected from peer-reviewed journals, books, government reports, and institutional publications using databases such as PubMed, Google Scholar, and PsycINFO. The search strategy incorporated keywords like domestic violence, childhood trauma, intimate partner violence, and psychological effects of abuse. . Studies published within last 20 years (2004–2024) were prioritized to ensure relevance, with a focus on empirical research, meta-analyses, and systematic reviews.

Thematic analysis was conducted to analyze findings into key areas, including short-term and long-term psychological effects (e.g., anxiety, depression, PTSD), cognitive and academic consequences, behavioral responses (e.g., aggression, social withdrawal, delinquency), and the role of resilience and protective factors. To comprehend the compounding impacts of domestic violence, additional factors were taken into consideration, including socioeconomic position,

cultural influences, and the prevalence of other unfavorable childhood experiences (e.g., parental neglect, parental substance abuse)

Limitations include cultural disparities in documenting domestic violence, which could

influence the generalization of results, and possible publication bias, as research with significant outcomes are more likely to be published. Access to significant foreign research may also be limited by the exclusion of non-English studies.

Strict consideration of ethical standards secured study integrity through reliable information, appropriate citation, and conformity to academic norms.

In order to help impacted persons and end the cycle of domestic violence, this study attempts to give a thorough knowledge of how domestic violence impacts children and highlight important areas for future research, intervention options, and reforming policies to support affected individuals and break the cycle of abuse.

Conclusion and Intervention

The widespread effects of domestic violence necessitate immediate, multi-level intervention to prevent long-term psycho-social consequences; interventions should begin at the individual level and progress to the community and societal levels to prevent long-term psycho-social consequences; comprehensive systems for tracking domestic violence, raising awareness, and integrating support from multiple sectors, including healthcare, education, and legal services; public awareness campaigns and preventive education in schools can empower individuals to recognize abuse and seek help early; psycho-social workers play a crucial role in supporting survivors by offering emotional support, creating safety plans, and advocating for their rights; they also help create awareness and gather data for policy-making to better address the issue; and by working with professionals from diverse sectors, psycho-social workers can contribute to breaking the cycle of abuse and promoting healthier communities.

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The Impact of Homework on Future Educational Prospects in Grade 01 and 02 students

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Abstract

Homework plays a pivotal role in early childhood education, due to enhance their future academic performance, generally described as a tool for motivating classroom activities and ensure essential study habits. Though there are critics contend that its benefits for young children are very limited and the outcomes are not as expected. The productiveness of homework in grade 1 and two remains as a controversial topic for a long time due to the influence of developmental, cognitive and socioeconomic factors. In this paper the writer would like to bring out how the homework help or hinder the advancement of the educational goals of grade 1 and 2 students. Through applying a systematic literature review this paper unveils the extent to which homework assists with educational or academic development, considering cogitative development and socioeconomic perspectives and long-term learning outcomes. Cognitive theories affirm that the children between 5 to 7 retain a very limited amount of working memory and capacity, based on that excessive homework may overwhelm the child instead of making them motivated in learning. Research highlights that, if the assignments and tasks which are convenient to their cognition and developmental aspects can helps in improving the cognitive skills and positive learning habits. On the other hand, excessive workloads may lead to increased stress and eventually its diminished interest in learning, and it will lead to potential disengagement from academic activities in later years. Considering developmental concepts, a child between 5 to 7 should have adequate play time, social or peer interactions, and adequate rest for proper development. Overburdening with homework may interfere with crucial developmental activities, affecting their emotional and social well-being and motivation to learn. Moreover, the role of parental involvement is significant in helping with homework in this age, as disparities in parental education levels, time availability, and socioeconomic conditions can create inequities in providing appropriate support in homework. It is quite obvious that students from high income backgrounds often cultivate greater parental assistance, structured home environments, and access to learning resources, though students from lower-income families may face difficulties due to a lack of supporting conditions. Findings from this review emphasize the need for policies on assignments and structured homework which are appropriate for the age, development and cognitive aspects should be assigned gradually ensuring it aligns with students' learning capacities. Educators must consider the different backgrounds of students and the availability of homework strategies that promote engagement, curiosity, and long-term academic success.

Introduction

Homework is considered as an essential element of education, which designed to improve the quality of learning and foster independent study. Nevertheless, its effectiveness in early years of education is still questionable. Although the homework which often expects to build foundational skills and study habits. research indicates the influences on long-term educational outcomes are unclear.

This paper addresses both the advantages and disadvantages of assigning a large amount of homework in early grades, considering its involvements for academic performance, socio-emotional wellness, and the formation of enduring learning habits.

More over this discussion will emphasize the impact of homework on the academic achievement, cognitive development, and motivation of young learners. Additionally, the paper will explore how parental involvement and socioeconomic factors affect the success of homework and the learning out- comes.

Literature Review

Today various researches and reports discuss the impact of homework on children between the age of 5 and 7 in various perspectives.

1. Theoretical Perspectives on Homework in Early Education

Cognitive Load Theory (Sweller, 1988) states that young children have limited working memory capacity. Excessive homework may overwhelm them, leading to stress and reduced retention of information (Sweller et al., 2011). While Skinner's behavioral learning theory argues reinforcement through repeated practice (homework) can enhance learning outcomes. However, motivation plays a crucial role in determining its effectiveness. (Skinner, 1953)

At the same time Social Development Theory discusses about the role of social interaction in learning. How a child learns from the social interactions and environment is to be considered in child development. Even though repetition can improve learning working memory, retention of information should be taken into account when assigning Home work, since over -load and overwhelming can affect the inner motivation and the natural desire of learning in young students.

It is no doubt that the involvement of parents in homework can support learning, but excessive parental assistance may hinder the development of independent problem-solving skills in children.

2. The Impact of Homework on Academic Performance

The relationship between homework and academic achievement in early grades is not much significant in the literature, few studies suggest that homework helps young students reinforce classroom learning and develop study habits that benefit them in later grades (Cooper et al., 2006). However, these benefits are more evident in middle and high school students.

On the other hand, Hattie (2009) found that homework has a negligible effect on learning outcomes in primary school students, with an effect size of only 0.15, whereas secondary school students benefit significantly more. A study by Farrow et al. (2019) found that while homework completion in early grades was correlated with higher test scores in later grades, the difference was marginal when controlling for socioeconomic factors and parental involvement.

3. Developmental Considerations

Young children require a balance between academic work, play, and rest for healthy cognitive and emotional development. Galloway et al. (2013) found that students in early grades who were assigned more than 30 minutes of homework per day reported higher stress levels and lower engagement in learning activities. Excessive homework can lead to stress and anxiety. It will hinder the natural desire for curiosity and exploring capacity in students.

According to the American Academy of Pediatrics (2016), structured playtime and family interactions are critical for early childhood development. Assigning homework in excess may reduce time for essential activities and interactions. If the child couldn't get enough social exposure and the experiences through interactions, potentially it may hinder social-emotional growth.

4. Socioeconomic Disparities and Homework Effectiveness

Parental involvement is a very crucial fact in assisting young children with their homework. But it varies based on socioeconomic status of the parents and their availability. Reardon (2011) indicates that students from higher-income families often receive more support with homework, contributing to disparities in academic achievement. On the other hand, not getting adequate help or guidance may lead to worry in children.

Access to resources influences homework effectiveness. Students from disadvantaged backgrounds may not have access to a quiet study environment, books, or parental support reducing the effectiveness of homework assignments (Cooper et al., 2006). Along with that inability to get tuition class guidance will also plays an important role in their academic achievement.

5. Homework and Future Educational Prospects

The long-term impact of homework in early grades on future academic performance is not proven but some longitudinal studies suggest that students who develop good homework habits early on perform better in later grades (Zimmerman & Schunk, 2011). Based on cognitive theories and developmental theories there is a chance for academical drop outs as well.

Other research indicates that early homework completion has minimal long-term benefits unless coupled with effective classroom instruction and engagement strategies (Marzano & Pickering, 2007).

Methodology

1. Research Design

Since this research is a secondary research thorough assessment of available literature is essential and appropriate. The journals, books and reports which discussed about the academic effects of homework on young elementary students, the developmental and psychological implications of homework, the socioeconomic factors that affect homework efficacy and the long-term educational results of early homework practices were mainly examined carefully to gather relevant data. Studies published between 2000-2024,peer-reviewed journal articles educational reports, research focusing on early elementary education (Grades 1-2), and studies examining academic performance, cognitive development, or long-term educational impact were prioritized while papers or studies on research on high school or college students, studies that focus on homework policies unrelated to academic outcomes and opinion-based articles without empirical evidence were excluded in the review.

2. Data Collection

The information for this review is gathered from various sources, including:

1. Academic Databases such as Google Scholar, ERIC, JSTOR, and PubMed
2. Government and educational research reports, publications from the American

Psychological Association (APA), National Education Association (NEA), and OECD Education Report

3. Peer-reviewed journals, educational research reviews, journals of educational psychology, and reviews of educational research were also used in gathering the data and relevant factors.

3. Data Analysis

Thematic analysis is employed to recognize recurring themes in the literature concerning the effects of homework on young students and it helped in qualitative analysis of this review. To get a quantitative synthesis, meta-analyses and statistical results from earlier research is conducted to evaluate the strengthens of the relationship between homework and educational outcomes.

4. Limitations of the Study

Different schools and nations follow different homework strategies, complicating direct comparisons.

Many studies emphasize immediate effects rather than the long-term impacts.

Disparities in parental engagement and support can distort results, with some students benefiting from more assistance than others.

Conclusion

The impact of homework on the future learning prospects of first- and second-grade students is not much significant and is determined by multiple factors such as cognitive process, developmental aspects, parental involvement, and the socio-economic status. While homework can enhance classroom learning and help primary school students to develop good study habits, its effectiveness in early childhood education remains controversial. Research shows that homework does not impact in larger on higher educational achievements. This is largely due to adolescents' limited intelligence, desire to learn through play, and desire to be well-rounded.

One of the concerns people have about homework and assignments is that heavy workloads may interfere with essential developmental activities such as play activities, socializing, and resting.

Young children learn best through exploration, experience and structured play and these activities support cognitive development. Too much homework limits the time available to complete these important tasks, and it may lead to stress, loneliness, and a decrease in the natural motivation to learn.

Socioeconomic disparity further complicates the educational process for young children. While students from higher-income families benefit from parental involvement, access to learning materials, and a supportive home environment and private tutoring facilities, children from low- income and marginalized families may face greater challenges in gaining assistance for homework. Limited parental support, a lack of quiet study spaces, unable to get tuition facilities and competing household responsibilities can make homework difficult to complete, ultimately it will cause achievement gaps.

Research shows that homework policies need to be reviewed in order to work and not

discriminate excessively between various student groups.

Given these factors, it is important for teachers, educators and policymakers to ensure that homework should be implemented appropriately. Homework should be moderate in size, developmentally appropriate, and designed to enhance learning without creating unnecessary stress. Activities should be purposeful, engaging, and structured, supporting young people's curiosity and creativity rather than relying on rote learning or repetitive tasks.

In conclusion, the study suggests that early childhood should fulfilled with play and interactions with the environment. Collaboration between families and schools will have an impact in young people's well-being and well-rounded development. By ensuring that school activities are meaningful, inclusive, and appropriate for student developmental factors, teachers are the people who can help students build a strong foundation for future academic success and make learning pleasurable and enjoyable rather than burdensome.

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Sociolinguistic factors contributing to the creolization process of the vedda language

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Abstract

Languages are the very important medium through which a person converses with others and apart from the communicative functions of a language, it depicts the cultural setting, traditions, lifestyles, customs, practices, norms, hierarchical features, and politics existing in a society. Creolization is the process of mixing two or more languages and creating a new language, having its roots going back to colonial rule. Indigenous people are generally defined as the original inhabitants of a particular region, possessing unique cultural practices, languages and social structures that are passed down through generations. 70% of the total indigenous people under the Sun live in Asia. One of the indigenous communities in Sri Lanka is the "Veddas" or "Wanniya-laeththo" community (forest-inhabitants).The word" Vedda" is derived from "Vyadda" of Sanskrit language (the hunter with a bow and arrow). Most of them live in "Mahiyanganaya" and other parts of the country such as Batticaloa, Trincomalee, Ratnapura, Anuradhapura etc. They were formerly hunters and gatherers. At present, Most of them are involved in sea-fishing (Eastern province), and farming. The current situation of Vedda language is that it has become a severely endangered language. The contact of the Veddas with the other people has influenced them and their language in numerous ways. There is a rapid decrease in the number of Vedda language speakers, influenced by socioeconomic, cultural, geographical and political factors. This study explores the factors which contribute to the contact of the Veddas with the other people and the decrease in the number of Vedda speakers. The present study employs a qualitative research approach. Academic literature served as the main source of data for the research. Scholarly articles and websites provided this paper with a range of information about the topic. The data were analyzed thematically in line with the research questions. The overall findings of the study suggest that as a result of their contact with the other communities Veddas, Veddas in Sinhalese-speaking areas are highly influenced by the colloquial Sinhalese and those living in close proximity to Tamils (Eastern province), are influenced by the Tamil Language. The analysis of the data revealed that geographical factors, demographic factors, social transaction, educational aspects, Social, economic cultural and political forces, attitudes of the speakers(youth), technology, modernism and urbanization have contributed to the creolization process of the Vedda language. The research concludes that so many extra-linguistic features have contributed to the contact of the Veddas with the others and resultantly, their linguistic decline.

Key words

communicative functions, modernization, extra-linguistic features, social transaction

Introduction

Languages are the medium through which one converses with others and apart from tLanguages are the medium through which one converses with others, and apart from the communicative functions of a language it depicts the cultural setting, the traditions, the lifestyles, customs, practices, norms, hierarchical aspects, politics, etc. of a society. In other words, a language has the social and cultural dimension as well. In the domain of sociolinguistics, researchers delve into the social aspects of languages which are

dynamic and are constantly evolving owing to various factors, including globalization and the rapid improvement in technology.

According to the Oxford Classical Dictionary, "creolization is a term referring to the process by which elements of different cultures are blended together to create a new culture. The word "creole "was first attested in Spanish in 1590 with the new meaning "Spaniard born in the New World." In Linguistics, creolization is the process of mixing two or more languages and creating a new language. The new language maintains the grammar of the vernacular language and the lexicon of a trade language. Creolization has its roots going back to colonial rule. At present, there are around 100 creoles in the world out of which 40 have English as a superstate, which clearly indicates the impact of British colonial rule. There are more than 75 million English-based creole speakers worldwide, e.g. Gullah, Haitian, Creole, Underdeutch, Sango, etc.

According to the Labor organization, almost 476.6 million tribes live in 90 countries worldwide, out of which, 70% of indigenous people live in Asia and Pacific. Sri Lanka is a multi-ethnic and multi-cultural country, comprising Sinhalese, Tamils, and Muslims as the main communities. One of the indigenous communities in Sri Lanka is the "Veddas" or "Vanniya-laeththo" community (forest inhabitants). They are the original/native community of the country and 2500 years later, Indian migrants established their settlements. The word "Vedda" is derived from "Vyadda" of Sanskrit language (the hunter with a bow and arrow). They were formerly hunters and gatherers. They are settled in various parts of the country. The Veddas in the Eastern province ('Muhudu') are involved in sea-fishing and others engage in farming. Most of them live in "Mahiyanganaya" and other parts of the country such as Batticaloa, Trincomalee, Ratnapura, Anuradhapura etc. The current situation of Vedda language is that it has become a severely endangered language (Weerasekara, 2020) and the UNESCO evaluation of the level of language endangerment confirms the above fact. The Vedda language is fast diminishing in the sense that the number of speakers is becoming less and less. Only 11% of the Veddas in Sri Lanka can speak their traditional language compared with 85% of the veddas not being able to converse in their traditional language. The majority of those fluent in their language belong to the age category of over 70, which is also a reason for the possibility of extinction of this language (Premakumara, 2011). Several sociolinguistic factors have contributed to the contact of the Veddas with the other people and the creolization process of the Vedda language.

Objectives

1. To understand the reasons for the contact of the Veddas with the outside people
2. To understand the psychological factors which contribute to the disuse of the Vedda language
3. To understand the Social, economic, cultural and political factors contributing to the creolization process of the Vedda language

Research Questions

1. What are the reasons for the contact of the Veddas with the outsiders?
2. What are the psychological factors which contribute to the disuse of the Vedda language
3. What are the social, economic, cultural and political factors contributing to the creolization process of the vedda language

Methodology

The present study employs a qualitative research approach. Academic literature served as the main source of data for the research. Scholarly articles and websites provided this paper with a range of information about the factors contributing to the contact of the Veddas with the other people and the decrease in the number of Vedda speakers. Thematic analysis was employed by the researcher to address the research problem in line with the research questions.

Findings and discussion

Attitude

Attitude of the youth/young generation towards the Vedda language is growing negative and they have started to feel as if their traditional language is not worth learning in comparison to learning Sinhalese or Tamil which might yield benefits upon them as a result of the constant contact with the outsiders, subsequent and consequent to their relocation from their original forests. The 5-18 year olds, for the most part, are not conversant in the Vedda language and the elderly generation speak to them in Sinhala. Therefore, the language is in danger when the speakers do not pass their linguistic traits onto the future generations (Weerasekara, 2021).

As to the geographical reasons, some development projects implemented by the government such as “Mahaweli” Development Project, Gal Oya Development project, Deduru Oya River projects, livelihood Development Projects, Agricultural projects and other irrigation extension projects have forced them to relocate from their places to other places where, with the contact of other people, they have had to change their cultural patterns, including language, leading to the disuse of their language.

As for the education, Veddas have faced a multitude of struggles. The formal education As for the education, Veddas have faced a multitude of struggles. The formal education was introduced in 1940s, but still, many have encountered numerous problems to get access to main education, special education or cultural education. There are no skilled teachers, only few facilities, and no supervision. Furthermore, in accessing little formal education, they are inclined towards changing their customs, dresses, etc on par with the other communities (Tamils or Sinhalese), leading to their cultural and linguistic destruction.

In terms of the economic dimension, due to the vulnerable nature of their (Veddas), socioeconomic conditions and enhanced social mobility, they engage in various jobs and transact social relationships. For instance, many of the Veddas in the Eastern part of the country have got married to Tamils and they place paramount importance upon Tamil or Sinhalese for their survival and for the betterment of their progeny. This cultural and social assimilation is the main cause for them to neglect their own language (Weerasekara, 2021). They live in the forest environment with natural food, shelter, rituals, communication, etc. However, the government law of prohibiting acquisition of natural resources, including forests has compelled them to change their economic means (Harrigan, 1954). With advancements in technology, globalization has reached its peak. As for the Veddas, the availability of radios and television is limited. There are a few mobile phones, laptops and other technical devices available and they mostly use various forms of traditional communication methods. Therefore, they are confined to a particular place and hence, they are not able to record their social, cultural, and historical events (Madhubhashini, 2021).

Conclusion

According to the study, the Vedda language is spoken only by a few in the country. The grandparent generation is cognizant of the traditional language; on the other hand, the younger generation, which has to proudly carry on their traditional values, seems negligent. In spite of the Veddas' wanting to live in their traditional homelands, preserving their culture, and making sure of their existence, including their language, owing to the above geographic factors, demographic factors, social transaction, educational aspects, socio cultural functions, political forces, tendency of the youth, the Vedda language seems to vanish. The government along with non-governmental organizations should introduce new policies to preserve this language which is threatened by globalization and modernization. The economic and social development of this community should be promoted and there should not be any negative influence by the external factors, since their economic and social stability will foster the development of their own language. Therefore, it is incumbent upon the governmental bodies, on-governmental bodies, policy makers, linguists and others, including the speakers themselves to ensure the existence of the Vedda language, which is on the verge of extinction due to the mixture or the creolization process of the language on account of the above-mentioned sociolinguistic factors.

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EmotiX: A Lexicon-Enhanced Deep Learning Model for Emotion Classification in Social Media

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Abstract

This study explored emotion classification in social media discourse using deep neural networks (DNNs) and lexicon-enhanced models. It analyzed tweets related to the Black Lives Matter Movement (BLMM), implementing and evaluating five architectures within the EmotiX framework: LSTM, Bi-LSTM, CNN, Hybrid (LSTM-CNN), and Enhanced Hybrid (LSTM-CNN). The NRC Emotion Lexicon was used to label emotions such as anger, joy, sadness, and fear. The dataset underwent pre-processing, including tokenization, stop-word removal, and lemmatization, before being fed into the models. Each architecture was assessed using accuracy, precision, recall, and F1-score to determine classification effectiveness. The Enhanced Hybrid LSTM-CNN model achieved the highest accuracy of 92%, outperforming standalone models like LSTM (85%) and CNN (87%). The hybrid architectures effectively captured both short-term local dependencies and long-term contextual patterns, reducing misclassification errors in closely related emotions. The findings contributed to a deeper understanding of public emotional responses in socio-political contexts and provided insights for social media monitoring and crisis communication strategies. This research demonstrated the effectiveness of hybrid deep learning models in emotion classification and highlighted the potential of integrating lexicon-based techniques with deep learning for improved accuracy. Future studies could explore real-time emotion classification, multilingual analysis, and transformer-based models to further enhance emotion detection in social media.

Early Warning Systems (EWS) for Student Dropout Prediction in The Education/Higher Educational Sector

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Abstract

School dropout remains a significant challenge in education and higher education. Various factors contribute to dropout rates, impacting individuals, institutions, and society. Early Warning Systems (EWS) have emerged as a promising solution to predict and prevent student dropouts using data analytics and technology. This paper provides an overview of existing research, methodologies, and challenges associated with EWS, emphasizing their role in educational sustainability and equity.

Introduction

Student dropout is a critical concern in education and higher education (Kumar et al., 2017). It disrupts learning, incurs financial losses for institutions, and hampers efforts toward inclusive education. Early Warning Systems (EWS) leverage data analytics to predict at-risk students and enable timely interventions (Nouri, 2019). This paper explores the significance of EWS, its methodologies, and associated challenges to enhance educational outcomes.

Importance of Student Dropout Prediction

Dropout rates are influenced by academic, emotional, social, and economic factors. Identifying at-risk students early allows institutions to provide support, significantly improving academic success rates (Del Bonifro et al., 2020). Dropout prevention has long-term societal benefits, including workforce development and economic stability (Dorn et al., 2021). Institutions increasingly adopt EWS to analyze academic records, personal data, and engagement metrics, applying targeted support strategies such as mentoring and counseling.

Challenges in Implementing EWS

Despite its advantages, implementing EWS presents several challenges (Zhang et al., 2023):

- Data Accuracy & Availability: Reliable data is essential for accurate predictions. Missing or inconsistent data can undermine system effectiveness.
- Privacy & Ethical Concerns: Institutions must ensure student data is collected, stored, and used ethically, complying with regulations.
- Bias in Machine Learning Models: EWS algorithms may inadvertently reinforce biases present in historical data, leading to unfair categorization of students (Akçapınar, 2019).
- Intervention Strategies: Effective response mechanisms are crucial. Institutions must allocate appropriate resources such as counselors, academic advisors, and social support services (Bañeres et al., 2020).

Challenges in Implementing EWS

EWS utilizes a combination of statistical analysis, machine learning, and predictive modeling to identify at-risk students. The following key data sources enhance predictive accuracy:

- Academic Performance: Grades, course completion rates, and standardized test scores.
- Socioeconomic Factors: Parental education level, financial background, and first-generation college status.
- Engagement Metrics: Attendance records, participation in extracurricular activities, and digital classroom interactions.
- Behavioral Indicators: Disciplinary records, changes in study habits, and course withdrawal patterns.

Research Methodology

This study employs a structured literature review, ensuring credibility and relevance by:

1. Data Collection: Identifying research papers, books, and reports from academic databases using specific keywords.
2. Screening & Inclusion Criteria: Selecting peer-reviewed sources with high relevance and credibility.
3. Data Analysis: Identifying recurring themes, emerging research areas, and key EWS challenges.
4. Critical Evaluation: Assessing research quality, biases, and limitations to provide a balanced perspective.
5. Synthesis of Findings: Integrating insights into a comprehensive analysis of EWS methodologies and their impact on student retention.

Conclusion and Future Directions

EWS is an evolving field with immense potential to transform education by predicting and mitigating student dropout risks. Future research should focus on:

- Enhancing predictive accuracy through advanced machine learning techniques.
- Integrating EWS with learning management systems for real-time monitoring.
- Addressing ethical concerns to ensure fair and responsible use of student data.

By continuously improving these systems, institutions can provide equitable educational opportunities, reducing dropout rates and fostering long-term student success.

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LAW

Investigating the Legal Challenges Posed by Artificial Intelligence in the Financial Sector: Analysis of the Current Legal Landscape and Future Regulatory Trends

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Abstract

The rapid advancements in the Artificial Intelligence have significantly transformed the financial sector. Key technologies such as transaction anomaly detection systems and automated trading algorithms have revolutionized financial operation demonstrating the immense potential of Artificial Intelligence to reshape the banking and financial sector. However, alongside these advancements, the adoption of Artificial Intelligence has introduced a host of complex legal challenges necessitating a comprehensive analysis of its implications on the financial sector.

Hence, this paper discusses the legal challenges faced by Artificial Intelligence. Namely, the lack of accountability, algorithm bias, invasion of privacy and data security concerns all of which increase the possibility of unfair treatment or discrimination. Large amount of data is required to train Artificial Intelligence models, which often comprises of sensitive personal data and financial data. Therefore, if any unexpected outcome takes place, the opacity of Artificial Intelligence decisions is a serious concern which makes it challenging to determine who has the accountability. In order to identify appropriate legal remedies for addressing these challenges, the article undertakes a thorough legal analysis of the regulatory frameworks governing Artificial Intelligence in the banking and finance sectors. The research employs a qualitative research methodology, analyzing a wide range of sources such as international treaties, regional regulations, domestic legislation, case law, and scholarly writing. Primary sources of the research include European Union General Data Protection Regulation 2018, the European Union Artificial Intelligence Act 2024, and domestic laws such as the General Data Protection Regulation and the Consumer Protection from Unfair Trading Regulations 2008. Meanwhile, the article has also analysed a range of secondary sources including numerous academic publications, policy reports.

In terms of the recommendation the article emphasizes the need for the financial and banking regulatory framework to clearly define the role of artificial intelligence and address the risks associated with its extensive use. such as the General Data Protection Regulation and the Consumer Protection Regulations plays a pivotal role in managing the intersection of Artificial Intelligence, data privacy, and consumer rights. Additionally, the article calls for strengthening consumer protection mechanisms to mitigate risks such as misinformation, unfair automated decision-making, and limited recourse for individuals adversely affected by Artificial Intelligence systems, advocating for a more robust regulatory approach to promote ethical Artificial Intelligence use.

In conclusion, while artificial intelligence has undeniably revolutionized the financial sector in the modern word, it also brings forth a complex array of legal challenges. Addressing issues such as accountability, algorithmic bias, and data privacy requires a forward-thinking regulatory approach that not only mitigates risks, but also promotes innovation.

This paper underscores the necessity of adopting cohesive legal frameworks, prioritizing consumer protection to build a more equitable and secure financial ecosystem.

Keywords

Artificial Intelligence, financial Sector, data privacy, consumer rights, accountability, personal data

The impact of crime against tourists on sustainable tourism: A case study of Unawatuna and Mirissa

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Abstract

In the 21st century, tourism has become a significant economic sector. Today, tourism is facing a variety of threats. Among them, crime is one of the major factors negatively affecting the growth of sustainable development. This paper aims to explore the impact of crimes against tourists on sustainable tourism development, with reference to Unawatuna and Mirissa in Galle district of Sri Lanka. The main hypothesis was that preventing crime against tourists can contribute to the growth of sustainable tourism. A survey was conducted from January to April 2023 and 2004, with 150 participants, including 100 tourists, 20 tour guides, 15 hotel managers and, 15 tour drivers. The study applied a stratified random sampling method to ensure proportional representation of different subgroups. The sample size represents a limitation of the study, but it objectively serves the purpose. Both primary and secondary data were collected. The Findings highlight that crimes against tourists have a detrimental effect on both the tourism industry and its sustainability. The primary impact is a negative image of a destination, which leads to a decrease in tourists demand and arrivals. The impact on individuals affected the tourist behavior and attitudes towards the country and location as well as their decision to visit or revisit where the criminal incidents occur. Reducing gaps in the control environment to ensure the safety of tourists, supporting the process of reporting crimes, preventing financial fraud and, renewing policies and laws are better suggestions for the growth of sustainable tourism development in Sri Lanka.

Keywords

Sustainable tourism, Crime prevention, Tourist security, Tourism

The Global Artificial Intelligence Revolution: Navigating the Intersection of Ethics and Law

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Abstract

Artificial intelligence (AI) is rapidly transforming various sectors globally, bringing both unprecedented opportunities and challenges. While AI promises innovation, efficiency, and significant societal advancements, its rapid development has also raised ethical concerns that require global regulation. Issues such as bias, privacy, human rights, and accountability are just a few examples of the profound ethical concerns associated with AI. Therefore, the objective of this research is to explore the need for a unified international framework on AI ethics to ensure responsible and equitable innovation across nations and sectors. Developing a global agreement on AI ethics is crucial to mitigate potential harms and promote its responsible use. The absence of a standardized ethical framework at the global level leads to fragmented AI governance, which poses risks of inconsistent application, ethical breaches, and unequal access to AI's benefits. This research aims to address the gap in international cooperation and governance regarding AI ethics. Specifically, it seeks to propose a global consensus on ethical standards for AI, with a focus on establishing a balanced approach that promotes innovation while safeguarding human rights and equality. To achieve this, the study utilizes a qualitative approach by analyzing existing ethical frameworks, international policies, and AI-related case studies. Preliminary findings indicate that a consensus on core ethical principles, such as transparency, fairness, and accountability, is essential for AI to serve humanity. However, challenges related to cultural diversity and differing technological capabilities between nations must also be considered. In conclusion, a global agreement on AI ethics is essential to ensure responsible innovation that benefits all of humanity. By establishing universal ethical principles, such as transparency, fairness, and accountability, the risks associated with AI can be mitigated while fostering equitable technological progress across diverse regions.

Keywords

Artificial Intelligence (AI), Ethics, Global Agreement, Responsible Innovation, Accountability, International Legal Framework.

Amending the Vienna Convention on Road Traffic for Autonomous Vehicles: Challenges and Opportunities for International Cooperation

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Abstract

The foundation for international traffic regulations and uniformity in national traffic regulations is based on the Vienna Convention on Road Traffic. However, the invention of autonomous vehicles (AVs) poses significant problems to this conventional framework, which relies on human drivers. So, it is necessary to modify the prevailing traffic regulations to match this technical advancement. Convention requires that a driver always retain control over a vehicle, establishing a legal obstacle to the comprehensive use of AVs. This study examines the difficulties and possibilities associated with revising the Vienna Convention to promote AVs' safe and effective incorporation into worldwide transportation networks. The primary research problem centers on the Convention's existing legal structure, which fails to specifically consider autonomous vehicles (AVs) and generally presumes that human operators are the main decision-makers in traffic situations. This drawback brings up concerns about safety, liability, moral decision-making, and the requirement for global standards. Without a single set of laws, the use of AVs may run into legislative discrepancies, which would hinder cross-border interoperability and technological advancement. The study aims to assess the present Convention's weaknesses, investigate possible changes, and propose procedures for global cooperation in AV regulation. The study employs a doctrinal research methodology. Also, used the data gathered from comparative case studies and interviews with experts. The legal analysis consists of a thorough review of the provisions of the Vienna Convention, pinpointing areas that may conflict with autonomous vehicle technology. Comparative case studies examine nations that have already begun to implement legislation for autonomous vehicles, such as Germany, the United States, and Japan, emphasizing effective practices and lessons learned. Furthermore, interviews with policymakers, legal experts, and leaders from the autonomous vehicle industry offer insights into the practicality and ramifications of modifying the Convention. The analysis investigates critical areas that need legal updates, such as clarifying the definition of "driver," creating liability structures for accidents involving autonomous vehicles (AVs), and incorporating ethical considerations of AI decision-making into traffic laws. A significant issue is achieving global agreement, considering that countries have different degrees of AV adoption and regulatory focus. Nevertheless, there are ample chances for worldwide collaboration, especially through initiatives from the United Nations Economic Commission for Europe (UNECE) and other global regulatory organizations. The study wraps up by stating that while it is essential to revise the Vienna Convention to keep pace with advancements in AV technology, a gradual and inclusive approach is necessary. Immediate solutions might include additional protocols or interpretative strategies permitting the conditional operation of AVs, whereas future amendments could re-evaluate legal definitions concerning vehicle control and accountability. Effective reforms will rely on international partnership, striking a balance between innovation and safety, and providing legal clarity for AV producers, regulators, and users. This research adds to the ongoing conversation about the regulation of autonomous vehicles (AVs), providing policy suggestions to

promote the worldwide implementation of AVs under a cohesive legal framework. By examining both the obstacles and prospects, the study underscores strategies for aligning international traffic regulations with the evolution of transportation.

Keywords

Vienna Convention, Autonomous Vehicles, Legal Framework, Traffic Laws

Legal and Regulatory Challenges of Governing the Advancement of Brain-Computer Interface Technologies.

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Abstract

Artificial intelligence has completely evolved modern healthcare, with its smart technology of patient centered medical services and diagnostic tools. Brain computer interface technology, which is a computer-based system, interprets brain signals and translate it into commands for external devices. This is one of the most interesting developments in Artificial Intelligence driven healthcare. This technology provides enormous potential with the ability to interact with the surrounding using neural impulses rather than physical. This is specially used for aiding people with neuromuscular disorders of amyotrophic lateral sclerosis, cerebral palsy, stroke, or spinal cord injury. In this backdrop, this paper analyses the legal and regulatory issues associated with the creation and application of Brain computer interface technology in the United Kingdom while stressing the implication of technology in society and medicine, as well as its inherent limitations. This swift advancement of Brain computer interface technology raises numerous legal challenges. Amidst those Patient's privacy, data ownership and consent as they are processing extremely sensitive neurological data are some main implications. Moreover, there are liability issues which still remain unsolved, particularly when it comes to malfunctioning devices or unintended consequences caused by the technology. Users could be exposed to illegal manipulation and hacking due to the vulnerabilities in Brain computer interface security. Therefore, it could have adverse impacts on those who depend on these devices for critical purposes.

This swift advancement of Brain computer interface technology raises numerous legal challenges. Amidst those Patient's privacy, data ownership and consent as they are processing extremely sensitive neurological data are some main implications. Moreover, there are liability issues which still remain unsolved, particularly when it comes to malfunctioning devices or unintended consequences caused by the technology. Users could be exposed to illegal manipulation and hacking due to the vulnerabilities in Brain computer interface security. Therefore, it could have adverse impacts on those who depend on these devices for critical purposes.

With an emphasis on the current regulatory framework of the United Kingdom, this paper examines the laws that are applicable to Brain computer interface technology. In order to do this the paper explores international legal framework including European Union laws, laws pertaining to data protection and cybersecurity. However, the findings suggest that there is no detailed legal framework tailored to address this field. Hence, this legislative gap highlights the need for comprehensive and more focused legislative regulatory framework which will be effective for developers of the technology, healthcare providers and users.

In summary, this paper provides a number of recommendations in order to resolve the complex legal and regulatory issues surrounding Brain computer interface with the aim to encourage responsible innovation while mitigating risks. Enhancing data protection will not only ensure the privacy of the neural data but also clarify the issues of data ownership.

This study emphasizes how legislative actions are required to implement precise, legally binding rules that can regulate the development of Brain computer interface technologies efficiently. In conclusion, this paper supports a balanced approach for Brain computer interface innovation that is geared towards research and development, guaranteeing strong risk management measures by law.

Comparative study of existing laws on IP challenges for AI-generated content

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Abstract

This proposal addresses the challenges artificial intelligence (AI) presents to existing intellectual property (IP) laws, which were designed primarily for human creators. As AI autonomously generates works such as art, music, and inventions, it raises critical issues about ownership and authorship. The paper proposes reforms to current IP frameworks, recognizing AI as a tool rather than a creator, with human users maintaining authorship. It suggests creating "AI-guided creation" clauses , establishing collaborative authorship categories, and exploring the possibility of granting AI legal entity status for IP ownership. Additionally, the proposal advocates for international cooperation to establish global standards for AI-related IP protections. These reforms aim to balance human creativity with AI's role in innovation.

Keywords

Artificial intelligence , authorship, intellectual property laws General Data Protection Regulation, California Consumer Privacy Act

Introduction

The legal landscape surrounding artificial intelligence (AI) is rapidly evolving, with existing laws being adapted to address AI-related challenges. Key areas of concern include intellectual property (IP) rights, such as copyright, patents, and trademarks, which raise questions about AI's role in creation and ownership. Privacy laws like the General Data Protection Regulation (GDPR) and California Consumer Privacy Act (CCPA) regulate AI's use of personal data. Liability and accountability issues, particularly regarding AI-caused harm or accidents, remain complex. Ethical frameworks are developing, with regulations like the EU's Artificial Intelligence Act aiming to ensure transparency and safety. However, challenges such as AI's legal status and bias remain unresolved, requiring ongoing legal adaptation.

AI has entered many facets of contemporary society. It is transforming industries, enhancing efficiency, and even affecting how we use technology, from basic devices to more complex structures.

The following are some of the main areas where AI is making an enormous distinction: AI has revolutionized research on drugs, customized treatment, and diagnostics, impacting the health sector's effectiveness. Algorithms can evaluate medical photographs, help forecast the course of a disease, and provide specialized treatment strategies. Artificial intelligence (AI)-powered educational platforms provide personalized assistance, adjust to students' requirements, and manage handling administrative tasks. This has impacted the advancement of the education sector.

Artificial intelligence helps businesses analyze market trends, optimize supply chains, enhance operations, and customize customer support. It is utilized in the financial industry for risk management, automated trading, and fraud detection. When it comes to the media and entertainment field AI could be utilized to generate preferences to suggest

content on services like Netflix and Spotify. Additionally, it is employed in the creation of video games, films, and even music. Additionally, AI makes gadgets like home security systems, heating and cooling systems, and smart speakers more sensitive to our wants and requirements.AI-powered autonomous cars seek to revolutionize transportation by perhaps lowering collision rates and facilitating traffic management

The relationship between intellectual property law and AI development must be addressed because certain legal issues regarding to the ownership of human creators and the rights of AI creations must be clarified. It is necessary to ascertain who is the owner of the rights to the works that AI systems produce, including literary content, audio recordings, artwork, and innovations. AI-generated works challenge the idea that traditional IP law normally assigns ownership to human creators. Should the rights belong to the person who developed the AI system? Or are they held by the AI's user? To prevent uncertainty and disagreements, this requires precise legal norms.

AI is an innovative technology. To promote more funding for research and development, it is crucial to safeguard the datasets, models, and algorithms that power AI technology. In order to promote a competitive and creative environment, businesses and individuals must make arrangements to ensure their AI-related intellectual property is protected against unlawful use or copying.

This part of the essay would be going to discuss the fundamentals of Intellectual Property Law in the Traditional Context with regards to copyright, patent and trademark. A type of legal protection known as copyright is given to writers of original works of authorship, including music, art, literature, and some other types of intellectual creations. The sole right to copy, distribute, perform, exhibit, and develop derivative works based on the original production is granted to the inventor. When the work is produced and fixed in a tangible form, such writing or recording, copyright protection is automatically applied. A patent is a type of legal guarantee given to creators of novel and practical discoveries or inventions, usually in the domains of science and technology. An invention must be new, non-obvious, and practical in order to be eligible for a patent. For a predetermined amount of time—typically 20 years—a patent grants the creator the only authority to create, utilize, market, or distribute the invention, prohibiting unauthorized usage. A trademark is a unique term, phrase, logo, symbol, or other identifier that is used to set one company's products or services apart from another. By guaranteeing that a company's products or services are identifiable, trademarks safeguard brands and aid in avoiding consumer confusion. As long as the mark is actively protected and in use, trademark protection may endure indefinitely.

A human-centric approach to innovation and creativity is reflected in the way intellectual property (IP) laws have historically been constructed around human creators, innovators, and entrepreneurs. The fundamental tenet of intellectual property law is that people should be given the rights to their creations or innovations in order to honor their intellectual labor and to encourage further advancement and artistic expression. This framework is based on the notion that since human effort and inventiveness are the foundation of these creations, people ought to have the sole right to their products.

The emergence of copyright law in the 18th century, for example, with the Statute of Anne in 1710 in England, which granted authors the right to control their published works, was driven by the desire to protect authors' rights while simultaneously fostering the public dissemination of knowledge. The historical development of IP laws started as a means of fostering creativity, invention, and commerce. The goal of this regulation was to uphold the rights of authors while also encouraging the general population to acquire knowledge. In a similar vein, European rulers gave the first patents in the late 15th century to encourage

technological and economic innovation. The United States' Patent Act of 1790 established a systematic legal framework to safeguard innovators by formalizing the patent-grant procedure. • The origins of trademarks may be traced back to the medieval period, when craftspeople used symbols to identify their products and set them apart from one another. During the Industrial Revolution, the current trademark system was created to assist companies in safeguarding their brands and guaranteeing that customers could accurately determine the origin of products.

These rules have continuously emphasized human ownership, authorship, and creation, even as they have been modified over time to better meet the demands of society and the changing economy. The fundamental tenet that human creators are the owners of intellectual property rights endures because it is believed that their labor and personal investment should be recognized by the law. However, with the development of artificial intelligence (AI), this human-centric approach is currently confronted with serious difficulties. There is growing discussion about whether traditional intellectual property (IP) frameworks, which are intended to safeguard human creators, can effectively handle authorship and ownership issues in a world where non-human entities contribute to or even independently produce creative works as AI systems start to produce art, inventions, and other creative outputs. As a result, there have been calls to reconsider IP laws in order to balance the need to preserve the rights of human creators with the role AI plays in innovation and creativity.

Considering intellectual property (IP) gives people's and organizations' inventions and creations legal protection, it is essential for promoting creativity, innovation, and economic growth. Fundamentally, IP law aims to balance the interests of the general public and artists. IP law helps guarantee that people or enterprises may maintain control over, profit from, and gain value from their intellectual creations by giving creators of original works, innovations, and brands exclusive rights. Consequently, this encourages more creativity and innovation.

By giving authors the sole right to their creations, intellectual property gives them legal protection. This gives creators—whether they be writers, inventors, artists, or companies—control over the use, duplication, and commercialization of their intellectual works. By preventing illegal use, duplication, or dissemination of their creations, these safeguards guarantee that authors keep ownership of their intellectual property. For writers, inventors, and artists to completely appreciate the worth of their creations, this sense of security is essential.

Literary and creative creations are protected by copyright, which gives authors and artists authority over how their works are distributed, reproduced, and shown in public.
For a set amount of time, usually 20 years, patents grant inventors the sole authority to create, utilize, and market their innovations.

Trademarks prevent others from abusing trademarks by protecting distinguishing signs or symbols

Artificial intelligence has emerged as a key instrument in the production of visual art. Machine learning algorithms are used by programs such as DALL·E and DeepArt to create original artwork in response to text prompts or pre-existing styles. After learning patterns, styles, and artistic approaches from analyzing enormous image collections, these AI algorithms create original artworks, frequently combining parts from several sources.
Artificial intelligence (AI) tools such as Google's DeepDream and Artbreeder can produce realistic or surreal landscapes and faces.

AI has advanced its ability to compose music in a variety of genres. AIVA (Artificial Intelligence Virtual Artist) and OpenAI's MuseNet are two examples of systems that can create creative music in a variety of genres, from pop to classical.

AI-Generated Literature: Stories, poetry, and even entire novels have been produced by AI. AI Dungeon and OpenAI's GPT-3 are two examples of tools that may generate text in response to user-provided instructions. To comprehend language usage, style, and story organization, these systems examine enormous volumes of written material. AI is capable of producing original novel chapters or short stories. An AI model and human authors collaborated on the 2020 book "1 the Road," which was based on Jack Kerouac's "On the Road."

Given that intellectual property (IP) rules have historically been human-centric, the topic of whether AI may be recognized as the creator or inventor under current legal frameworks offers a number of difficulties. Legal systems are struggling with how to manage the role of non-human entities in the creation process as artificial intelligence (AI) plays an increasingly significant part in the production of art, inventions, and other intellectual works. The following are some of the main obstacles:A creator or inventor is often defined by IP laws, such as copyright, patent, and trademark laws, as a person who has put intellectual effort into the creation or innovation. This conventional view is predicated on the idea that only people are capable of the kinds of creative and mental processes that are eligible for intellectual property protection. The foundation of copyright laws is the requirement that the creator of a work of authorship be a human being. Since current laws do not recognize machines as writers, this becomes problematic when works are created totally or mostly by AI.An inventor must be a natural person in order to receive a patent. When AI systems produce new inventions, courts and patent offices have to decide whether the invention should be attributed to the AI or whether human involvement is enough to qualify the person as the inventor.

Similar problems may develop in trademark law when AI systems are used to design brands or logos. Trademarks are still assumed by legal systems to be connected to real entrepreneurs or businesses. This makes it difficult to decide who is the rightful owner or author of works produced by AI, particularly when the AI dominates the creative process. Legal systems generally demand that a work or invention be attributed to a human creator who may be credited with original idea, design, or ingenuity in order to grant IP rights. When AI systems produce art, the following questions arise:What amount of human involvement is required for an innovation or work to qualify as human-generated? Can a human be regarded as an author if an AI system creates a piece on its own just because they trained the AI or set the parameters?

Does the AI itself become the "inventor" or "author," or is the human who supplied the original information or parameters still the legitimate creator, if the AI creates an invention or piece of art with little to no human involvement? Is the scientist who supplied the original dataset or the AI itself credited as the inventor, for example, if an AI system creates a novel medicinal compound on its own?

Traditionally, intellectual property law links a creation's rights to its human author. But if AI produces anything on its own, it raises issues around ownership. For example, ownership is usually assigned to the inventor under patent law and to the author under copyright law. AI cannot possess intellectual property rights under existing frameworks since it is not a legal person or business. Legal systems must therefore figure out how to assign title to the owner of the AI system or the person who developed it.

produced by a contractor or employee while they are employed is owned by the

employer in many jurisdictions. However, if a business uses AI to produce art, it begs the question of whether ownership should remain with the corporation or if a new framework is needed to handle AI-driven innovation. IP regulations varies from nation to nation, and various jurisdictions are reacting differently to the emergence of AI. Certain nations, like the UK and the EU, have looked at certain guidelines or frameworks for dealing with AI-generated works. However, there is currently no universal agreement on how to treat AI in relation to intellectual property law, which leaves creators and innovators operating internationally in the dark.

This part of the essay would discuss key cases on the complicated concepts of ownership, authorship, and inventorship in a world where robots actively produce intellectual property and instances of IP conflicts involving AI-generated works. These case studies demonstrate how the emergence of AI technologies is posing a challenge to established IP rules.

The "Edmond de Belamy" AI Art Case considered the sale of an AI-generated artwork called "Edmond de Belamy" at Christie's Auction House in 2018 for more than $432,000 sparked intense discussion on ownership and authorship. Obvious, an art group located in Paris, used a machine learning technique known as GAN (Generative Adversarial Network) to construct the piece.

The primary concern of dispute was authorship. Because they gave the first guidance and taught the AI model, the artists behind Obvious asserted authorship and ownership even though the artwork was produced by an AI. This, however, sparked debate about whether the AI itself should be given credit for creation or if the human developers should be given credit.

The sale of the artwork brought to light the legal ambiguity surrounding AI-generated works and how conventional copyright laws, which are a human-centered, find it difficult to account for the participation of machines in creative processes, even if no court decision was rendered specifically on the issue of ownership.

In the Stephen Thaler" Patent Case whether patent law, which normally requires that the inventor be a human, might recognize an AI as an inventor. According to Thaler, DABUS should be given credit for the invention since it was its creator. The U.S. Patent and Trademark Office (USPTO) in the US denied the application, citing the need that inventors be human. The idea that patent law necessitates human inventors was further supported by the rejection of the application by the UK Intellectual Property Office and the European Patent Office (EPO). In a rare case when an AI was acknowledged as an inventor, the South African Patent Office, nevertheless, approved the application and awarded the patent.
This case has spurred continuous discussions about whether patent laws should be changed to acknowledge AI as a possible inventor and has brought attention to the legal difficulties in applying existing patent laws to AI-produced ideas.

In this case of the AI-Generated Book" (2020), authorship was the issue at hand.
Co-written by AI and human authors, the novel "1 the Road" was released in 2020. An AI system generated the novel's text in response to prompts, with human authors offering guidance and editing. When a large amount of a work is produced by AI, who should be given credit as the author? Is it better to accept the AI system as well as the human authors as the only creators? The AI's contribution to the creative process was recognized, and the human authors were given credit when the book was published. The case brought to light the problem of handling collaborative projects that incorporate both machine-generated and human inputs. It brought up significant issues surrounding co-authorship in the AI era, especially with regard to how far AI may be regarded as a

creative collaborator.

This part of the essay would be going to discuss the extent of the robustness of the current laws on data privacy and protection. There is presently no complete or uniform collection of laws especially created to address artificial intelligence (AI), and the legal landscape surrounding AI is continually developing. Rather, existing rules in domains like intellectual property (IP), laws on privacy, ethical considerations and liability are being used to solve AI-related challenges. AI is governed by the General Data Protection Regulation (GDPR) of the European Union, specifically with regard to the processing of personal data. AI systems that handle personal data must abide by the rules of fairness, transparency, and data protection. For example, under GDPR, people have the right to contest automated decisions. Similar data privacy protections are provided by the California Consumer Privacy Act (CCPA) in the United States, which has an effect on the use of AI systems that handle personal data.

As per Product Liability Traditional liability laws are frequently insufficient to decide who is liable—the AI developer, manufacturer, or operator—if an AI system causes injury (as in the case of self-driving cars, for example). As a result, there are gaps in accountability for the actions of AI. International organizations and certain nations have begun to create ethical standards for the advancement of AI. For instance, in its published guidelines on AI ethics, the European Commission exhorts developers to make sure AI systems are accountable, transparent, and free from bias. Labor laws may need to change to address worries about automation's effects on employment, worker rights as AI takes on more activities that have historically been completed by humans. International collaboration is necessary for the development and regulation of AI. The global governance of AI and IP has been discussed by the OECD and the World Intellectual Property Organization (WIPO), but international harmonization is still a problem.

As previously stated, the traditional idea of human authorship is challenged by AI's involvement in creativity, and many legal systems have not yet addressed the issue of ownership and rights over content produced by AI. In conclusion, present AI laws are a combination of pre-existing frameworks that were not created with AI in mind and newly developed, AI-specific legislation. With major ongoing discussions about how to assure AI's safe, ethical, and equitable usage, the legal environment is changing.

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Digital Transformation and Its Effects on Traditional Business Models

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Abstract

The digital age has ushered in significant shifts in the global business landscape, prompting organizations across industries to rethink their traditional business models. This research explores the phenomenon of digital transformation and its profound effects on traditional business models, particularly focusing on how companies are adapting to technological advancements and the challenges they face in navigating this shift. Digital transformation encompasses the integration of digital technologies into all areas of a business, fundamentally changing how businesses operate, deliver value to customers, and compete in the marketplace. The core objective of this study is to examine the ways in which digital transformation is reshaping traditional business strategies, organizational structures, customer engagement models, and revenue generating methods. The research begins with an overview of traditional business models, analyzing how businesses have historically operated, including the reliance on physical assets, face-to-face interactions, and hierarchical organizational structures. These models, while successful for decades, are increasingly being disrupted by digital technologies that enable automation, real-time data analytics, global connectivity, and more personalized customer experiences. The study examines how industries like retail, manufacturing, and financial services have been particularly affected by digital transformation, noting that companies in these sectors are increasingly adopting digital technologies to remain competitive. The second section of the paper focuses on the drivers behind digital transformation, including the rapid adoption of cloud computing, the rise of big data, the proliferation of mobile devices, and the growth of artificial intelligence (AI) and machine learning. These technologies have enabled businesses to streamline operations, enhance decision-making processes, and offer innovative services. However, the research also highlights the challenges companies face in implementing digital strategies, such as resistance to change, lack of digital skills among employees, cybersecurity concerns, and the need for significant investment in technology infrastructure. A significant portion of the dissertation is devoted to examining how traditional business models are evolving in response to digital transformation. For instance, in the retail sector, the rise of e-commerce has prompted brick-and-mortar stores to develop omnichannel strategies, blending in-store experiences with online platforms. In the financial services industry, fintech startups are challenging traditional banks by offering digital-first solutions such as mobile banking, peer-to-peer lending, and blockchain-based transactions. The study also highlights how industries are increasingly shifting toward subscription-based models, leveraging data to offer customized services, and using digital platforms to engage with customers in innovative ways. Moreover, the research investigates the implications of digital transformation on organizational structures. Traditional hierarchical models are giving way to more agile, cross-functional teams that emphasize collaboration, innovation, and adaptability. The paper explores how businesses are restructuring their operations to foster a culture of digital innovation, with an emphasis on leadership's role in driving this transformation. Finally, the dissertation offers a forward-looking perspective on the future of digital transformation and its potential to further disrupt traditional business models. It discusses how emerging technologies such as blockchain, AI, and Internet of

Things (IoT) will continue to drive change, and how businesses must adopt a mindset of continuous innovation and flexibility to survive and thrive in the digital era. In conclusion, this research underscores the critical importance of digital transformation for businesses seeking to maintain competitiveness in an increasingly digital world. The study offers practical recommendations for organizations to successfully navigate the challenges of digital transformation, including the need for strategic vision, investment in technology, and organizational agility.

Keywords

Digital Transformation, Business Models, Innovation, Strategy, Automation, Artificial Intelligence, Organizational Structure, Competitiveness

Leadership Styles in the Age of Digital Transformation in Sri Lanka

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Abstract

The advent of digital transformation has profoundly impacted the way organizations operate, requiring a shift not only in technological strategies, but also in leadership styles. This research explores how leadership styles in Sri Lanka are evolving in response to the demands of digital transformation, focusing on the ways in which leaders in Sri Lankan organizations are adapting to new technological environments and shaping organizational culture. As businesses in Sri Lanka, like elsewhere in the world, navigate digital disruptions, leadership has become a critical factor in ensuring that organizations can effectively manage change, foster innovation, and remain competitive in an increasingly digital marketplace. The study begins by defining digital transformation and identifying its key components, including the integration of digital technologies such as artificial intelligence, big data, cloud computing, and automation. These technologies are reshaping industries across Sri Lanka, driving the need for leaders to adapt their management styles, decision-making processes, and organizational strategies. Traditional leadership models, which often emphasized hierarchical structures, authority, and control, are increasingly being challenged by the need for greater collaboration, innovation, and agility in the digital age.The research examines various leadership styles, including transformational, transactional, and servant leadership, and assesses their relevance in the context of digital transformation in Sri Lanka. Transformational leadership, which emphasizes inspiring and motivating employees, is particularly significant in driving cultural change and fostering innovation within organizations. Transactional leadership, on the other hand, focuses on structured processes and rewards for performance, which may be less effective in a rapidly changing digital environment that requires adaptability and responsiveness. Servant leadership, which emphasizes a focus on the needs and development of employees, is also explored, particularly in the context of building trust and engagement during times of digital disruption. Through qualitative methods, including interviews with Sri Lankan business leaders, managers, and employees, the research highlights the specific challenges that leaders face in implementing digital strategies and managing organizational change. The study reveals that many leaders in Sri Lanka face difficulties in balancing traditional leadership approaches with the demands of a digital-first environment. Additionally, leaders must address issues such as employee resistance to technological change, lack of digital skills, and concerns about data security and privacy. The research also identifies the importance of developing a digital-savvy leadership cohort capable of making strategic decisions that align with technological advancements. Furthermore, the study examines how Sri Lankan leaders are leveraging digital tools to enhance communication, collaboration, and decision-making within their organizations. The shift towards more decentralized, flexible, and networked structures is identified as a significant trend, requiring leaders to develop new skills in managing virtual teams, fostering innovation, and driving employee engagement in a remote or hybrid work environment. The role of leadership in building a digital culture that embraces change, experimentation, and continuous learning is also emphasized. The research concludes by offering recommendations for Sri Lankan leaders to enhance their effectiveness in the digital age. These include investing in digital leadership training, promoting cross-functional collaboration, fostering a culture of innovation, and developing leadership

strategies that align with technological advancements. The findings suggest that effective leadership in the age of digital transformation requires a blend of traditional leadership qualities and new, adaptive approaches that are responsive to the rapidly evolving business landscape. Ultimately, this study contributes to the understanding of how leadership in Sri Lanka is evolving in the face of digital transformation, offering valuable insights for organizations aiming to thrive in the digital age.

Keywords

Leadership, Digital Transformation, Sri Lanka, Innovation, Organizational Culture, Adaptability, Technological Change, Transformational Leadership, Digital Skills, Collaboration

Legal Challenges in Protecting Intellectual Property Rights in the Digital Age in Sri Lanka.

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Abstract

The digital age has brought about transformative changes in how intellectual property (IP) is created, distributed, and consumed. With the advent of the internet, social media platforms, and digital content-sharing technologies, Sri Lanka, like many other countries, faces significant legal challenges in protecting intellectual property rights (IPR). This research examines the complex legal landscape surrounding intellectual property in Sri Lanka, particularly in the context of the digital era. It critically explores the difficulties faced by lawmakers, regulators, and IP holders in ensuring that intellectual property rights are effectively protected in an environment characterized by rapid technological advancements, widespread internet use, and increased digital piracy. The first part of the research provides an overview of Sri Lanka's existing intellectual property laws, including the Intellectual Property Act No. 36 of 2003, and analyzes the legal framework that governs copyright, patents, trademarks, and trade secrets in the country. While these laws are largely based on international agreements such as the Trade-Related Aspects of Intellectual Property Rights (TRIPS) Agreement, the research highlights the challenges posed by the digitalization of content and the global nature of the internet. The study identifies key issues such as the difficulty in enforcing IP rights in an online environment, the rise of digital piracy, and the loopholes in existing laws that fail to address the nuances of digital platforms, such as social media networks, file-sharing services, and e-commerce websites. A significant portion of the dissertation is dedicated to analyzing the challenges of enforcing copyright in Sri Lanka, where the proliferation of unauthorized digital content remains a persistent issue. The research examines how local copyright laws are applied to digital works, such as music, movies, software, and literary content, and assesses their effectiveness in combating online piracy. The study also looks into the role of Digital Millennium Copyright Act (DMCA)-style laws and whether such models could be adopted or adapted in Sri Lanka to strengthen protections against digital infringement. The research also highlights the issue of jurisdictional challenges, particularly when digital content crosses international borders, complicating legal actions against infringing parties. In addition to copyright, the research delves into the protection of trademarks and patents in the digital age. The rise of online counterfeiting, where digital platforms are used to sell counterfeit goods, poses a significant threat to trademark holders in Sri Lanka. Similarly, the advent of digital technologies and online business models presents challenges in safeguarding patents and trade secrets. The study critically analyzes the application of existing laws to these issues and evaluates the potential for legal reforms that would better accommodate the digital marketplace. Furthermore, the dissertation explores the role of digital platforms and intermediaries, such as internet service providers (ISPs) and content-sharing websites, in the protection of IP rights. The research investigates the extent to which Sri Lanka's legal framework holds these platforms accountable for the content they host, and the challenges in balancing the protection of IP with freedom of expression and internet access. The evolving nature of IP laws in response to technological innovations, such as blockchain and NFTs (Non-Fungible Tokens), is also examined, with a focus on how these developments could impact future IP law in Sri Lanka. The dissertation concludes with a set of recommendations

aimed at strengthening Sri Lanka's intellectual property framework to meet the demands of the digital era. It suggests legislative reforms, improved enforcement mechanisms, enhanced public awareness campaigns, and greater collaboration between government authorities, the private sector, and international bodies. Ultimately, this research provides valuable insights into the legal challenges of protecting intellectual property in the digital landscape of Sri Lanka and offers practical solutions to address these issues in a rapidly evolving global environment.

Keywords

Intellectual Property, Digital, Copyright, Enforcement, Piracy, Trademarks, Patents

Sexual Harassment Law: Evolving Standards and Workplace Regulations in Sri Lanka

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Abstract

Sexual harassment in the workplace is a pervasive issue that affects individuals worldwide, and Sri Lanka is no exception. Over the years, the country has seen significant strides in addressing sexual harassment in the workplace through legislative reforms, institutional frameworks, and evolving social attitudes. However, the progress remains uneven, and the legal landscape continues to evolve. This dissertation explores the development of sexual harassment law in Sri Lanka, focusing on the evolving standards, regulatory frameworks, and the challenges associated with their implementation. The research critically examines the laws governing sexual harassment in Sri Lankan workplaces, including the 1995 enactment of the "Prevention of Sexual Harassment in the Workplace" regulation, and its subsequent amendments and judicial interpretations. The first part of the dissertation reviews the historical context of sexual harassment laws in Sri Lanka, tracing their roots in international conventions and the gradual influence of global movements such as the #MeToo movement. The analysis highlights how the legal response to sexual harassment in Sri Lanka has evolved in alignment with international standards set by the United Nations and the International Labour Organization (ILO). The research examines the role of Sri Lanka's legal system in interpreting and enforcing sexual harassment laws, assessing the progress made in the formalization of workplace regulations and policies. The dissertation also investigates the content of Sri Lanka's legal framework concerning sexual harassment, focusing on the definitions, categories of harassment, and mechanisms for reporting and redress. It critically assesses the strengths and weaknesses of the legal provisions, identifying gaps that hinder effective implementation. This includes challenges such as a lack of awareness of legal rights, insufficient enforcement of policies, and cultural barriers that discourage victims from coming forward. The study highlights the role of employers in creating safe and supportive workplaces, and the obligations placed upon them by law to prevent and address instances of sexual harassment. A significant portion of the research delves into case law, evaluating how courts in Sri Lanka have handled sexual harassment claims and the evolving interpretations of workplace harassment. The analysis focuses on landmark cases and the legal precedents they set, assessing the degree to which judicial decisions have impacted the development of sexual harassment law in the country. Furthermore, the research explores the influence of public opinion, civil society advocacy, and employer-employee dynamics on the ongoing discourse surrounding workplace harassment. Through qualitative research, including interviews with legal experts, HR professionals, and victims of harassment, the dissertation identifies the practical challenges faced by victims of sexual harassment in Sri Lanka. It also examines how workplace cultures, organizational attitudes, and systemic structures play a critical role in either enabling or preventing harassment. The research further investigates the role of unions, legal aid organizations, and civil society groups in promoting awareness and legal reform. Finally, the dissertation offers recommendations for reform, proposing legislative and policy changes to better align Sri Lanka's sexual harassment laws with international best practices. It emphasizes the need for comprehensive training programs, robust enforcement mechanisms, and greater societal awareness to prevent sexual harassment and ensure a safer, more equitable work environment for

all employees. By providing a comprehensive analysis of sexual harassment law in Sri Lanka, this dissertation contributes to the ongoing discourse on workplace rights, gender equality, and legal reform, offering valuable insights for policymakers, legal practitioners, and advocates for social justice.

Keywords

Sexual harassment, Workplace, Law, Awareness, Equality

The Impact of Artificial Intelligence on Legal Ethics: Challenges and Opportunities for Legal Practice

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Abstract

The rapid advancement of Artificial Intelligence (AI) technologies has significantly transformed various industries, including the legal profession. This research explores the impact of AI on legal ethics, focusing on the challenges and opportunities that arise as AI becomes increasingly integrated into legal practice. With AI tools now capable of conducting legal research, analyzing contracts, and even predicting case outcomes, the potential for efficiency gains is undeniable. However, these developments also raise important ethical questions concerning accountability, bias, transparency, and the preservation of professional judgment in legal decision-making. This paper examines the ethical dilemmas posed by AI, such as the risk of reinforcing existing biases in legal systems, and the responsibility of legal professionals in managing AI-driven tools. Furthermore, it discusses the opportunities AI presents in improving access to justice, reducing costs, and enhancing legal research capabilities. Through a critical analysis of current applications, legal frameworks, and regulatory standards, this study aims to provide a comprehensive understanding of how AI is reshaping legal practice and what ethical safeguards need to be implemented to ensure the responsible use of AI in law. Ultimately, this paper suggests that while AI offers transformative potential for the legal field, careful consideration of its ethical implications is essential to maintain the integrity and fairness of the justice system. This research could explore the growing integration of artificial intelligence in the legal field, focusing on its ethical implications, potential challenges, and the opportunities it presents. Key aspects of this topic could include:

- How AI is being used in legal research, contract analysis, and even in predicting case outcomes.
- Ethical concerns surrounding AI's potential to replace human judgment in legal practice.
- The risks of bias in AI algorithms and the implications for fairness in the legal system.
- The role of lawyers and regulators in overseeing AI-driven legal processes.
- Opportunities for AI to improve access to justice, especially in underserved communities.

This topic would allow you to examine the intersection of law, technology, and ethics, making it highly relevant in today's rapidly evolving legal landscape.

Keywords

Artificial Intelligence, Ethics, Accountability, Transparency, Justice, Decision-making, Technology

The Rise of E-commerce and Its Impact on Traditional Retail in sri lanka

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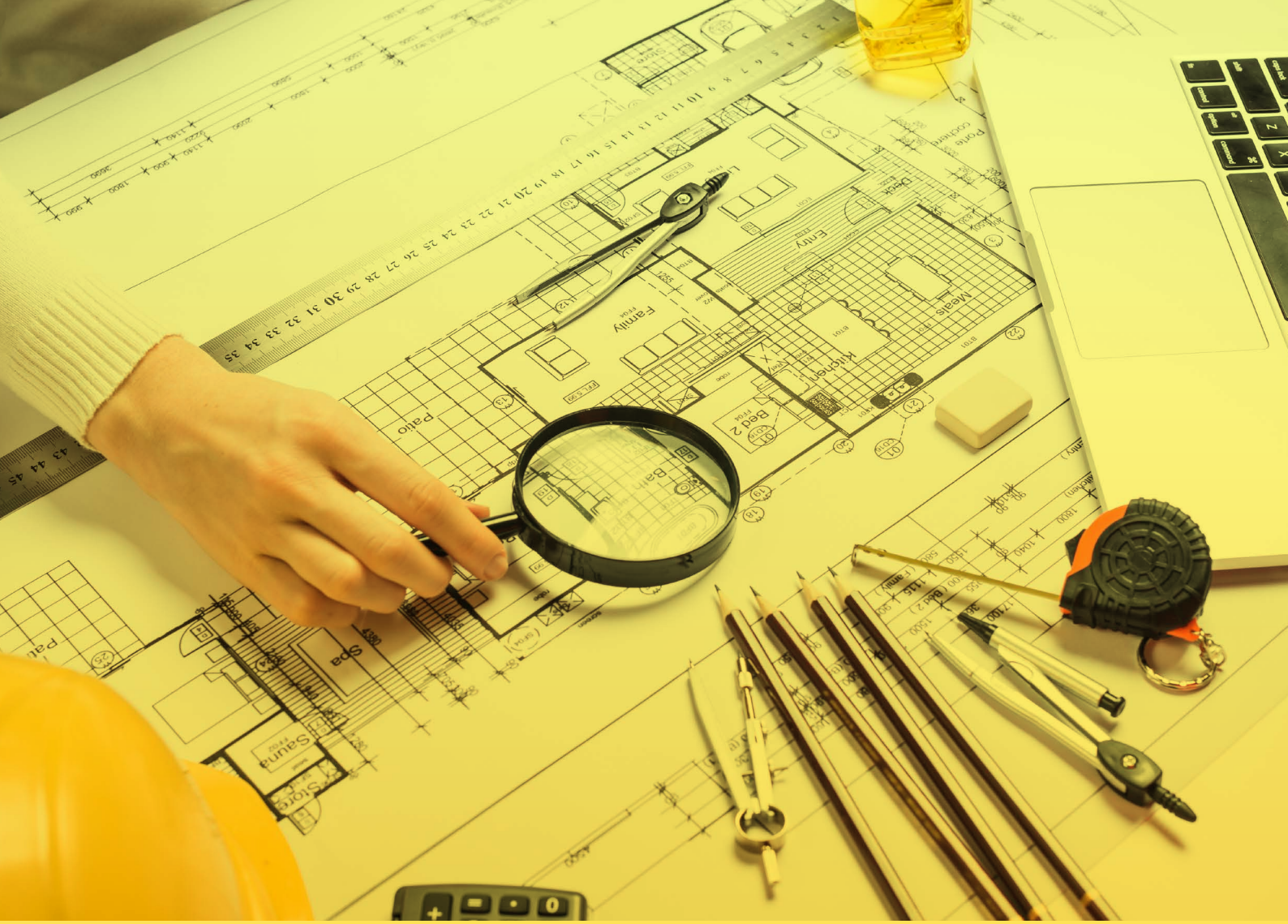
Abstract

The rise of e-commerce has revolutionized the global retail industry, significantly impacting traditional brick-and-mortar retail models. In Sri Lanka, as internet penetration and mobile device usage have surged in recent years, e-commerce has become a driving force in reshaping consumer behavior, business operations, and market competition. This research examines the growing influence of e-commerce in Sri Lanka and its disruptive impact on traditional retail businesses. It explores the challenges faced by local retailers, the opportunities created by e-commerce, and the strategies adopted by businesses to navigate this rapidly changing retail landscape. The study begins by providing an overview of the current state of the retail sector in Sri Lanka, outlining the dominance of traditional retail channels and consumer reliance on physical stores. However, with the widespread adoption of digital technologies and the expansion of online marketplaces, there has been a marked shift in consumer shopping preferences towards the convenience and accessibility of e-commerce. The research explores how local businesses, particularly small and medium-sized enterprises (SMEs), are responding to this transformation. Factors such as increased internet access, improved digital payment systems, and changing consumer expectations have accelerated the shift toward online shopping, with significant consequences for traditional retail stores. The research delves into the specific challenges that traditional retailers in Sri Lanka face in the face of growing e-commerce competition. Many local retailers have struggled to adapt to the digital shift due to limited technological infrastructure, lack of e-commerce knowledge, and challenges in integrating online and offline sales strategies. The study highlights how these challenges have impacted profitability, customer loyalty, and the overall competitiveness of traditional retail businesses. Additionally, concerns about the digital divide and the unequal access to technology between urban and rural areas are discussed, as these disparities affect how different segments of the population engage with e-commerce platforms. On the other hand, the study also identifies the opportunities created by e-commerce for traditional retailers who embrace digital transformation. The research examines how retailers can leverage e-commerce platforms, social media, and digital marketing strategies to reach a wider audience, improve customer engagement, and enhance their competitive advantage. Case studies of Sri Lankan businesses that have successfully adopted e-commerce models are provided, illustrating how these companies have used technology to expand their reach, diversify their product offerings, and create a seamless omnichannel shopping experience. The integration of online ordering with physical store operations, or “click-and-collect” services, is also discussed as an emerging trend that enables traditional retailers to bridge the gap between online and offline shopping experiences.Furthermore, the research investigates the role of e-commerce giants such as Daraz and Takas in transforming the retail environment in Sri Lanka. These platforms have significantly altered consumer expectations, with consumers now seeking convenience, variety, and competitive pricing. The rise of e-commerce has also led to a surge in logistics and delivery services, creating new business opportunities while posing additional challenges for traditional retailers to maintain efficient supply chain operations. The study concludes by offering recommendations for traditional retailers in Sri Lanka to thrive in the digital age. These include embracing digital transformation, investing in e-commerce infrastructure, adopting innovative marketing

strategies, and fostering customer-centric business models that cater to the evolving needs of the digital consumer. The research suggests that while e-commerce presents significant challenges to traditional retail, it also offers opportunities for growth, provided that retailers can successfully adapt and integrate online and offline strategies. In conclusion, this research highlights the profound impact of e-commerce on traditional retail in Sri Lanka, offering insights into how businesses can navigate this digital shift to remain competitive and sustainable in the evolving retail landscape.

Keywords

E-commerce, Retail, Transformation, Consumer, Digital, Technology, SMEs



ENGINEERING

Impact Of Chemical Stabilizers on The Performance of Concrete Paving Blocks

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Abstract

In Sri Lanka, there is a significant prevalence of pavement distresses, which are primarily caused by the inadequate stability, strength, and quality of the materials utilized during the construction process. These issues can result in various forms of deterioration, ultimately affecting the performance and longevity of the pavements. The aim of this study was to explore potential solutions to mitigate pavement distress by improving the stability and strength of the materials used. To achieve this, various mineral and chemical stabilizers were tested in different proportions to evaluate their effects on the properties of the developed blocks.

Laboratory experiments were conducted to assess key parameters, such as compressive strength, tensile strength, and water absorption. The results revealed that the highest compressive strength achieved was rounded off to 26 MPa, while the highest tensile strength recorded was 3.7 MPa. In terms of water absorption, the most effective chemical stabilizer was found as eggshell powder (ESP), with a water absorption rate of 1.8%.

Based on the test results, the optimum dosage of ESP was observed to be 10%. A combination of these materials greatly improved general performance, especially strength, by reducing water absorption in pavement blocks. The most valuable information deduced from this study has immense implications for the construction industry, particularly with regard to pavement enhancement in terms of resilience and durability. The use of appropriate chemical stabilizers in construction practices can significantly enhance both the quality and sustainability of infrastructure development, leading to the creation of more durable and long-lasting pavements.

Keywords

Paving blocks, Stabilizers, Compressive strength, Water Absorption, Splitting Tensile Strength

Introdction

Concrete paving blocks are extensively utilized in the construction industry for a wide range of applications, such as roadways, sidewalks, driveways, and other surface areas that require durable and stable material. The mix design methodology for concrete paving blocks, along with its procedure, was first introduced by Dowson in the 1980s. Since then, the use of paving blocks has become increasingly popular due to their versatility, ease of installation, and cost- effectiveness in various construction projects.

However, in Sri Lanka, the performance of paving blocks is often compromised by a variety of distress issues. These distresses issues can be attributed to several factors, including the environmental conditions, traffic load, and the quality of materials used during the manufacturing process. Environmental factors, such as extreme weather

conditions, temperature fluctuations, and exposure to moisture, can cause the paving blocks to degrade over time. The pressure from heavy traffic loads and improper material composition further exacerbates the deterioration of the blocks.

A study by Amarasiri et al. (2020) highlighted that excessive wear and polishing of paving blocks are particularly prevalent in tourist zones, where high foot traffic and vehicle movement are common. This wear and tear can lead to slippery surfaces, which pose safety risks to pedestrians and vehicles, requiring frequent maintenance to ensure the integrity and safety of the paving. Additionally, Jayasinghe et al. (2018) have identified that one of the major causes of paving block distress, particularly in flood-prone areas, is the absence of a proper drainage system. Standing water will thus accelerate deterioration of the paving blocks and lead to more frequent repair and maintenance activities, emphasizing the importance of an effective drainage system in those areas.

All of these studies emphasize the importance of considering both environmental and design factors together when implementing paving block systems. Key factors such as proper drainage, the use of high-quality materials, and designing pavements to withstand local traffic conditions are crucial in preventing distress and prolonging the service life of paving blocks.

Methodology

Material Selection

Ordinary Portland cement, Fine aggregate (River Sand), Coarse aggregate (Chip stones), Stabilizers (Mineral and Chemical) and Water were used as materials. Eggshell Powder (ESP) and Gypsum Powder were used as chemical stabilizers to cast the paving block samples. Standard ratio was Cement: Fine aggregate: Coarse aggregate = 1: 2: 3.

Sample	Cement		Fine Aggregate		Coarse Aggregate - Chip stones
	Cement	Gypsum Powder	Sand	Eggshell Powder	
Set 05 - Mix A	90%	10%	100%	-	100%
Set 05 - Mix B	85%	15%	100%	-	100%
Set 05 - Mix C	80%	20%	100%	-	100%
Set 06 - Mix A	100%	-	90%	10%	100%
Set 06 - Mix B	100%	-	80%	20%	100%
Set 06 - Mix C	100%	-	70%	30%	100%
Set 07 - Mix A	90%	10%	90%	10%	100%
Set 07 - Mix B	85%	15%	80%	20%	100%
Set 07 - Mix C	80%	20%	70%	30%	100%

Table 1: Chemical Stabilizers mix proportions – percentages by weight

Specimen Preparation

Based on the proposed mix proportions in Table 1, the paving block specimens were cased with molds dimensions of 20 cm × 10 cm × 6 cm. Specimens were removed from molds and subjected to moisture-curing for a period of 28 days in order to maintain the moisture.

Results and Discussion

Analysis of Compressive Strength of paving block specimens

ESP and gypsum powder were tested under chemical stabilizers and the impact of each stabilizer on the functioning of casted paving blocks has been discussed in this section.

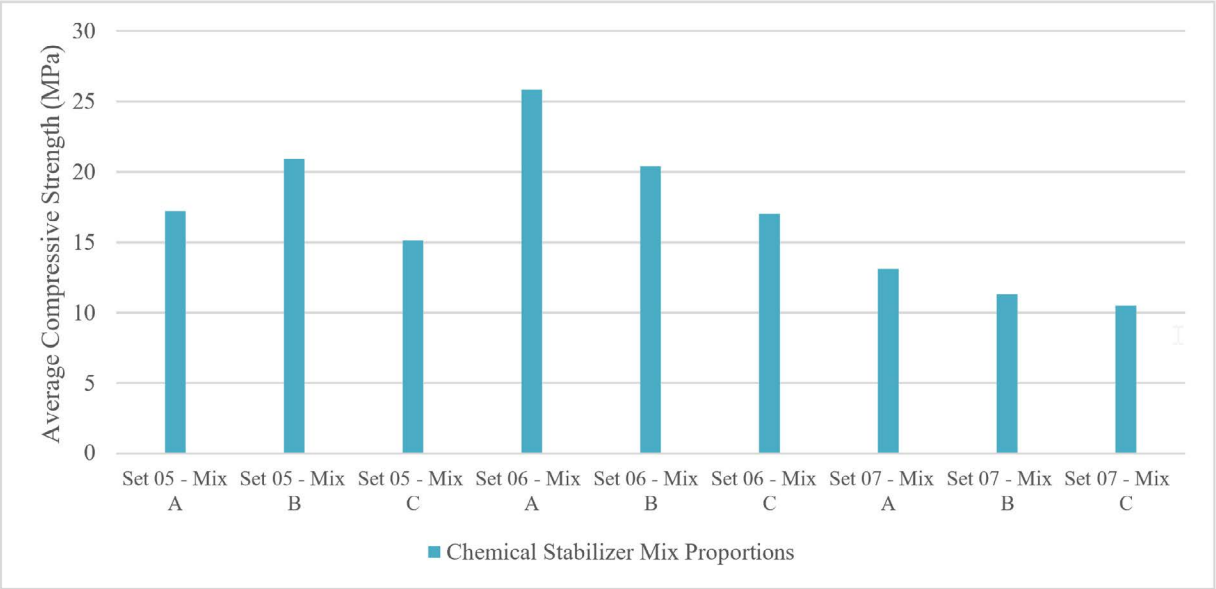

Figure 1: Compressive Strength of Specimens containing Chemical Stabilizers

For chemical stabilizers, stabilizers were not introduced as a partial replacement for chip stones. Therefore 100% chip stones were used for the casting of all the paving block samples. Accordingly, the highest average compressive strength among the above was ESP mix proportion of 10% as the partial replacement for sand (Set 05 Mix A), as 25.8MPa. The lowest compressive strength was from Set 07 Mix C which was 10.5MPa.

Analysis of Compressive Strength of paving block specimens

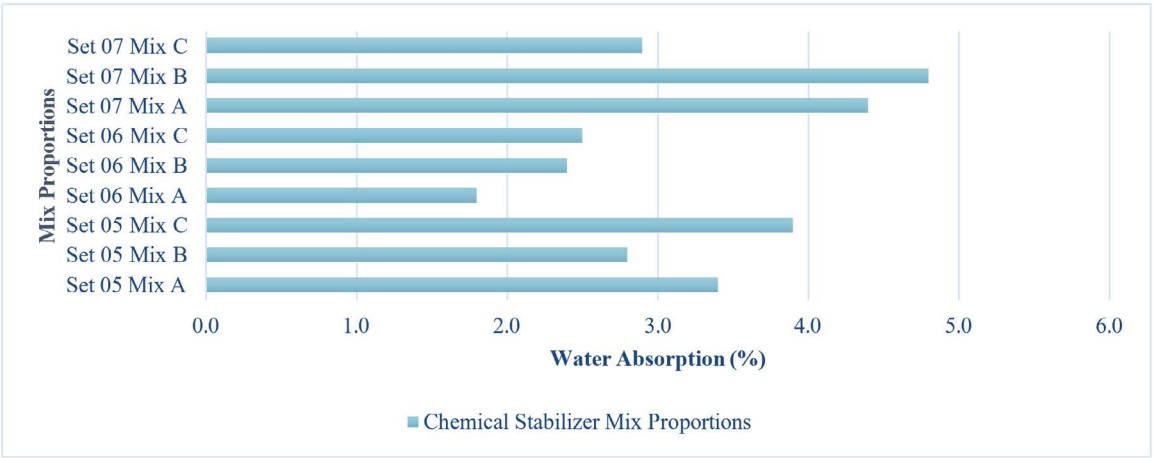

Figure 2: Water Absorption of specimens containing Chemical Stabilizers

Among the various selected mix proportions and stabilizers, the mix consisting of 10% ESP and 90% sand demonstrated the lowest percentage of water absorption, indicating that it provides the most effective chemical stabilization compared to the other mixes. This makes it the most suitable mix proportion in terms of chemical stabilizer performance.

When analyzing the overall performance of all the mixes, Set 07 Mix B stands out as having the weakest compaction. This particular mix exhibited a water absorption rate of 4.8%, which is considerably higher than the other mixes. This elevated water absorption suggests that Set 07 Mix B is less efficient in terms of compaction and overall structural integrity, potentially making it less suitable for applications requiring higher durability and performance.

Analysis of Tensile Strength of paving block specimens

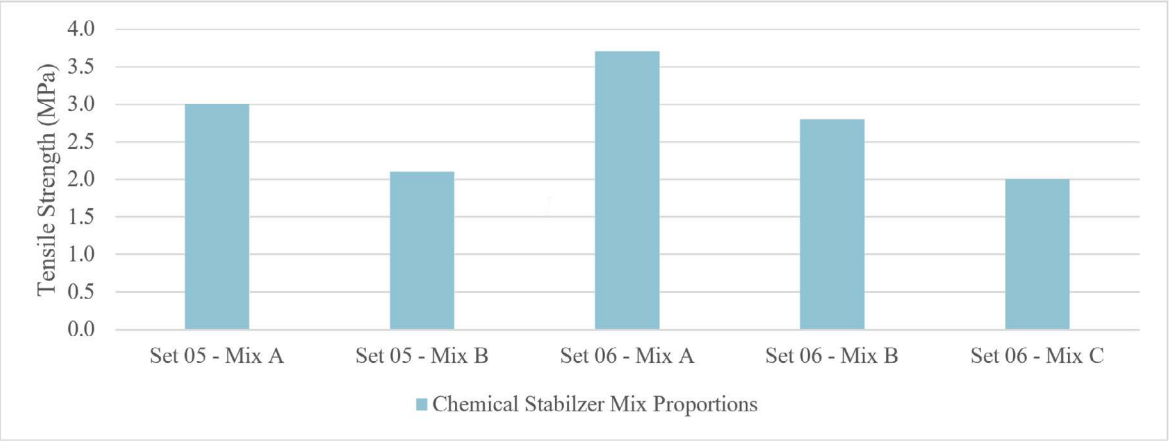

Figure 3: Tensile Strength of specimens containing Chemical Stabilizers

As shown in Figure 4, the mix with 20% gypsum powder resulted in a tensile strength of less than 2.0 MPa, which does not meet the requirements of the test standard BS 6717:2001. As a result, this data is not considered valid and is not reflected in the graph. On the other hand, the 10% ESP (Set 06 Mix A) proportion is identified as the most suitable mix for this study, as it achieved a tensile strength of 3.7 MPa. However, this value is still slightly lower than the 3.9 MPa threshold, which is the standard tensile strength expected according to BS 6717. Regarding gypsum powder, the 10% proportion can be considered the most appropriate mix when using it as a chemical stabilizer, as it provided the highest tensile strength in the test.

In contrast, when examining the three stabilizer-combined mixes under the tensile splitting strength test, all of them exhibited tensile strengths lower than 2.0 MPa. These values are considered to fall within the failure-block range, meaning they are not capable of meeting the necessary structural requirements for resisting tension and load. Consequently, these mixes are not depicted in the graph, as their performance does not satisfy the expected standards for tensile strength. Based on this analysis, it can be concluded that these stabilizer-combined mixes are not adequate for applications that require resistance to tension and load-bearing capacity.

Discussion of specimens contained mineral and chemical stabilizers

When considering the overall performance of chemical stabilzers, the best-performing stabilizer was identified as eggshell powder (ESP). The suitable mix proportion for ESP was the same for all the test results, which was 10%. Hence 10% ESP can be determined as the suitable chemical stabilizer and mix proportion percentage with a clear clarification. The study showed the maximum compressive strength value as 22.8 MPa with a 15% variation in glass powder content. As a justification, the use of glass powder is effective as a substitute for partial sand at 15% of coarse glass powder (Islam, Rahman and Kazi, 2017).

Conclusion and Recommendations

eggshell powder (ESP) has been found to as the best-performing chemical stabilizer.

The most favorable results were achieved with a consistent mix proportion of 10% ESP, with 90% sand, 100% cement and 100% chip stones by weight. The findings have evidently established 10% ESP as the suitable chemical stabilizer for improving concrete paving blocks' performance.

The research study can be strengthened through several recommendations for future investigations. These include increasing the sample size and quantity, incorporating abrasion resistance testing, and optimizing mix designs. It is also recommended to use both mineral and chemical stabilizers in future studies to assess their combined impact. Furthermore, as no replacement for coarse aggregates was used in this study, future research should explore partial replacements for coarse aggregates (from both chemical and mineral stabilizers), to evaluate their effects on performance.

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Assessing the Effectiveness of Ground Improvement Methods for Reclamation Lands

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Abstract

Land reclamation using dredged sea sand has become a prevalent practice in Sri Lanka for the development of coastal infrastructure, primarily due to the abundance and cost-effectiveness of this material. Despite its advantages, dredged sea sand presents several geotechnical challenges due to its loose and highly compressible nature, which can lead to significant issues such as excessive settlement, low bearing capacity, and an increased risk of liquefaction. These challenges pose a threat to the long-term stability and safety of infrastructure built on reclaimed land. Therefore, effective ground improvement methods are essential to enhance the performance and durability of dredged sea sand in construction projects. This paper will look at the effectiveness of three of the widely used techniques in improving the ground at dredged sea sand-filled areas, namely, vibro compaction, dynamic compaction, and surcharge preloading.

Field data are analyzed to investigate the performance of these methods in terms of the major parameters: compaction efficiency, reduction in settlement, and improvement in bearing capacity. Additionally, the cost-effectiveness of each method was studied in order to select the most appropriate ground improvement technique for Sri Lankan coastal infrastructure projects. It is expected that the findings from this research will be of great significance for engineers and policymakers in helping ensure long- term stability and sustainability of Sri Lanka's reclaimed lands.

Keywords

Ground Improvement, Vibro Compaction, Dynamic Compaction, Surcharge Preloading

Introduction

The study utilizes data from the East Container Terminal construction project at the Port of Colombo, where extensive ground improvement works were carried out to enhance soil stability. The evaluation criteria included Cone Penetration Test (CPTu) data, borehole investigations using Standard Penetration Test (SPT), and Field Density Tests (FDT). Additionally, settlement monitoring data for surcharge preloading was analyzed over time to assess its long- term effectiveness. A detailed cost analysis was conducted using Bill of Quantities (BOQ) data, and Microsoft Excel was used for computations. The effectiveness of each method was compared based on relative density improvements, settlement reduction rates, time efficiency, and environmental impact. The study also considered factors such as soil permeability, grain size distribution, and groundwater conditions, which influence the selection of an appropriate improvement technique.

Methodology

Vibro Compaction:
This technique proved highly effective in enhancing relative density at depths greater

than 8.8 meters, achieving optimal compaction while minimizing settlement risks. With a compaction rate of 0.5 meters per minute, it is one of the fastest available methods. Additionally, vibro

compaction was found to be the most cost-effective method, priced at 267 LKR/m². Its moderate vibration impact makes it suitable for use in proximity to existing structures, making it particularly well-suited for urban and port development projects.

Dynamic Compaction:
Dynamic compaction was found to be most effective for depths less than 8.8 meters, particularly in high-permeability sandy soils. However, it requires significant energy input (3800 kJ per impact) and generates substantial ground vibrations, making it unsuitable for areas near sensitive infrastructure such as buildings and bridges. The method also proved to be more expensive, with a cost of 2686 LKR/m², significantly higher than vibro compaction. Moreover, dynamic compaction required multiple passes to reach the desired compaction levels, leading to longer execution times.

Surcharge Preloading:
This method was effective in reducing settlement, particularly in areas with underlying silt layers that hindered other improvement techniques. However, it required a lengthy duration— approximately three months per site—to achieve the target settlement values, making it the slowest technique among the three. The high cost of implementation, at 16,931 LKR/m², was largely attributed to the need for temporary surcharge loads and extended monitoring periods. While surcharge preloading is beneficial for long-term settlement control, its extended timeline and high cost made it less practical for projects with tight schedules.

Based on the collected data, vibro compaction proved to be the most effective and cost-efficient method for improving dredged sea sand in Sri Lanka. It outperformed dynamic compaction in terms of deep compaction performance and was notably more time-efficient compared to surcharge preloading. Additionally, vibro compaction had a lower vibration impact, making it suitable for a wider range of applications, including areas near sensitive structures.

Observations from the East Container Terminal project revealed that areas treated with vibro compaction showed consistent and uniform density improvements. In contrast, sections treated with dynamic compaction required additional corrective measures to address the excessive vibrations. While surcharge preloading was effective in areas with underlying silt layers, it proved impractical for sites requiring fast-tracked construction, due to its prolonged implementation time.

Conclusion

Based on this study, the most appropriate ground improvement technique for reclaimed dredged sea sand in Sri Lanka is vibro compaction. It offers the best combination of cost efficiency, time effectiveness, and suitability for use near existing structures. These findings recommend deep sand compaction with vibro compaction; dynamic compaction can be done where vibration sensitivity is not so critical. It is clear that although surcharge preloading seems quite efficient regarding ensuring settlement control, its long-term implementation makes this method more relevant for projects that have flexible time frames.

The study offers recommendations on selecting the most appropriate technique of ground improvement for future similar reclamation projects in Sri Lanka and other

countries along coastlines. Further research might be explored to identify the hybrid methods of improvement that have higher performances but at lower costs, such as a combination of vibro compaction with dynamic compaction. Advanced numerical modeling techniques can be applied to simulate the long-term behaviour of improved ground under various loading conditions; this will go a long way toward understanding the sustainability and performance of these methods over time.

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Predicting Policy-Driven Adjustments in Construction Cost Estimates

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Abstract

Cost estimation in construction is an important measure of project management since it primarily depends on financial planning, resource allocation, and profitability. For financial planning, several measures are required, such as material costs, labour expenses, and pricing strategies through markup or discount. Therefore, several studies have investigated the factors affecting these cost components due to their dynamic nature. Markup is applied to ensure profitability. Discounts help optimize costs. Contractors may offer discounts to their customers to win project contracts while balancing profitability with market competitiveness. Therefore, the right pricing strategy is critical in cost estimation. Accordingly, numerical data are insufficient to predict the total estimation. Textual data can significantly enhance the accuracy of total estimation. This research aims to predict policy-driven adjustments (discounts or markups) in construction cost estimates based on structured and unstructured features (policy reasons). This study utilized the dataset available on Kaggle. In this research, textual features are transformed into high-dimensional embeddings that capture their semantic meaning using the pre-trained Sentence Transformers model. Therefore, this study utilized NLP to process the textual data and transform it into a structured form. Moreover, numeric features are standardized using Standard-Scaler to ensure that features have a similar scale. This study also performed additional data preprocessing techniques, such as outlier removal. Three advanced regression algorithms were used such as Random Forest Regressor, LGBM Regressor, and Gradient Boosting Regressor. The performance of the models was evaluated using two metrics such as MAE and R2 score. This study identified that the Random Forest Regressor achieved the lowest MAE (4880.17).

Keywords

Policy-driven adjustment prediction; Cost estimation; NLP; Random Forest Regressor

Application of Boiled Bamboo Fiber as an Alternative Material for Fiber Reinforced Concrete

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Introduction

Concrete is one of the most widely used construction materials, yet its brittleness under tensile forces remains a significant challenge. To mitigate this issue, fiber-reinforced concrete (FRC) has been introduced, incorporating synthetic fibers such as carbon and steel fibers. However, due to environmental concerns and high costs associated with synthetic fibers, alternative sustainable materials are being explored. This study investigates the viability of boiled bamboo fiber as an alternative to synthetic fibers in fiber-reinforced concrete. Bamboo, a naturally abundant material, has been historically used in construction due to its high tensile strength and rapid growth rate. The objective of this research is to analyze the compressive strength of concrete reinforced with boiled bamboo fiber and compare it with conventional carbon fiber-reinforced concrete.

Methodology

The study followed a structured experimental approach to evaluate the compressive strength of bamboo fiber-reinforced concrete (BFRC) and carbon fiber-reinforced concrete (CFRC). The methodology included material selection, fiber extraction, mix proportioning, casting, curing, and compressive strength testing.

Materials and Fiber Extraction

- Ordinary Portland Cement (OPC) was used as the binding material.
- Fine aggregate (natural river sand) and coarse aggregate (crushed limestone, 5-20mm in size) were used.
- Synthetic carbon fiber and mechanically extracted boiled bamboo fiber were utilized as reinforcement.
- Bamboo fibers were extracted mechanically and boiled for five hours to enhance fiber bonding properties before being cut to lengths of 3-4mm

Mix Design and Concrete Preparation

Concrete mix proportions were designed based on British Standards (BS EN 14889-2:2006 and Eurocode 2) for two different grades: C30 and C40. The mix was prepared in a vertical axis concrete mixer, where fibers were evenly distributed by hand. The fresh concrete was tested for workability using the slump test, and specimens were cast in 100mm × 100mm × 100mm cube moulds.

Mix Design and Concrete Preparation

Mix Type	Cement (kg/m^3)	Fine Aggregate (kg/m^3)	Coarse Aggregate (kg/m^3)	Water (kg/m^3)	Fiber (kg/m^3)	Admixture (kg/m^3)	Density (kg/m^3)
C30 (BFRC)	390	875	950	174	3.9	1	2420
C40 (BFRC)	445	796	974	174	4.5	1	2420

Curing and Testing

- Specimens were de-molded after 24 hours and cured in a water tank for 7 and 28 days.
- Compressive strength tests were conducted using a universal testing machine following BS EN 12390-3:2019.
- A total of 36 specimens were tested, with CFRC serving as the control.

Results and Discussion

The slump test results indicated that both CFRC and BFRC exhibited comparable workability, satisfying the design criteria. The compressive strength results revealed that BFRC outperformed CFRC in both C30 and C40 mix designs.

Compressive Strength Results

Concrete Mix	3 Days (MPa)	7 Days (MPa)	28 Days (MPa)
C30 (BFRC)	22.7	33.5	38.3
C30 (CFRC)	22.3	29.0	37.4
C40 (BFRC)	29.8	39.5	45.0
C40 (CFRC)	28.6	31.7	43.0

The improvements in compressive strength can be attributed to the strong fiber-matrix bonding achieved through the boiling process, which enhances the fiber's ability to bridge cracks and distribute stress more efficiently. Additionally, the natural composition of bamboo fibers contributes to better energy absorption and crack resistance.

Compressive Strength Comparison

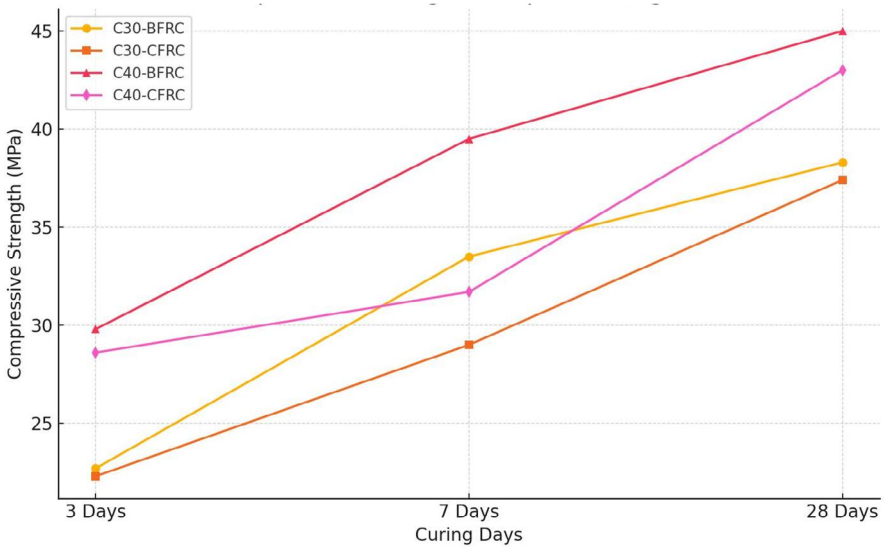

Figure 1 - Compressive Strength Comparison

Conclusion and Future Work

This study demonstrates the potential of boiled bamboo fiber as a viable alternative to synthetic carbon fiber in fiber-reinforced concrete. The findings indicate that BFRC not only meets but exceeds the compressive strength of conventional CFRC, making it a promising sustainable alternative for construction applications.

Future research should focus on evaluating the flexural and tensile properties of BFRC, optimizing fiber content, and exploring its durability under various environmental conditions. By integrating bamboo fibers into construction materials, the industry can

move towards more environmentally friendly and cost-effective building solutions.

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Post-Pandemic Recovery and Challenges in Construction Project Management in Sri Lanka

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Introduction

The COVID-19 pandemic has had a profound impact on various sectors globally and the construction industry is no exception. Given the physical nature of construction work, the pandemic-induced lockdowns, social distancing measures, and supply chain disruptions led to severe project delays, cost overruns, and resource shortages. In Sri Lanka, where construction plays a vital role in economic development, these challenges were exacerbated due to the reliance of the country on imported materials and labor. This study examines the multifaceted impact of the pandemic on construction project management in Sri Lanka and explores effective recovery strategies.

Problem Statement

Construction projects require significant on-site labour, precise scheduling and a steady flow of materials. However, the COVID-19 pandemic introduced unprecedented constraints including

- Delays due to lockdown measures and travel restrictions.
- Supply chain disruptions leading to material shortages.
- Increased costs due to inflation and prolonged project timelines.
- Health risks among workers, affecting labour availability.

The study aims to identify key management challenges faced during the pandemic and propose strategies for mitigating similar disruptions in the future.

Objectives and Research Questions

This research focuses on the following objectives

1. To analyze the impact of COVID-19 on construction project management in Sri Lanka.
2. To identify critical challenges faced by stakeholders in the construction industry.
3. To propose project management techniques for overcoming pandemic-induced disruptions.

Key research questions include

- How did COVID-19 impact construction project timelines and budgets?
- What measures were implemented to manage labor shortages and supply chain disruptions?
- How can construction firms build resilience against future disruptions?

Methodology

- A mixed-methods approach was adopted, combining quantitative and qualitative data collection
- A structured questionnaire was distributed among 97 professionals, including project managers, quantity surveyors, engineers, and contractors.
- Semi-structured interviews were conducted with industry experts to gain a deeper insight into the challenges faced.
- Frequency Index (FI) analysis was used to rank challenges based on survey responses.

Key Findings and Analysis

Major Challenges Identified

The study identified several challenges that affected construction project management during the pandemic. These were ranked based on their Frequency Index (FI)

Rank	Challenge	FI Score
1	Project delays and extended timelines	7.66
2	Supply chain disruptions	6.40
3	Reduced labour availability	5.12
4	Economic uncertainty and inflation	5.00
5	Contractual disputes and legal issues	4.31

Impact on Project Timelines and Costs

The most significant impact observed was project delays, as illustrated in Figure 1. Nearly 76% of respondents reported continued project execution with disruptions, while 17% indicated that projects were stalled.

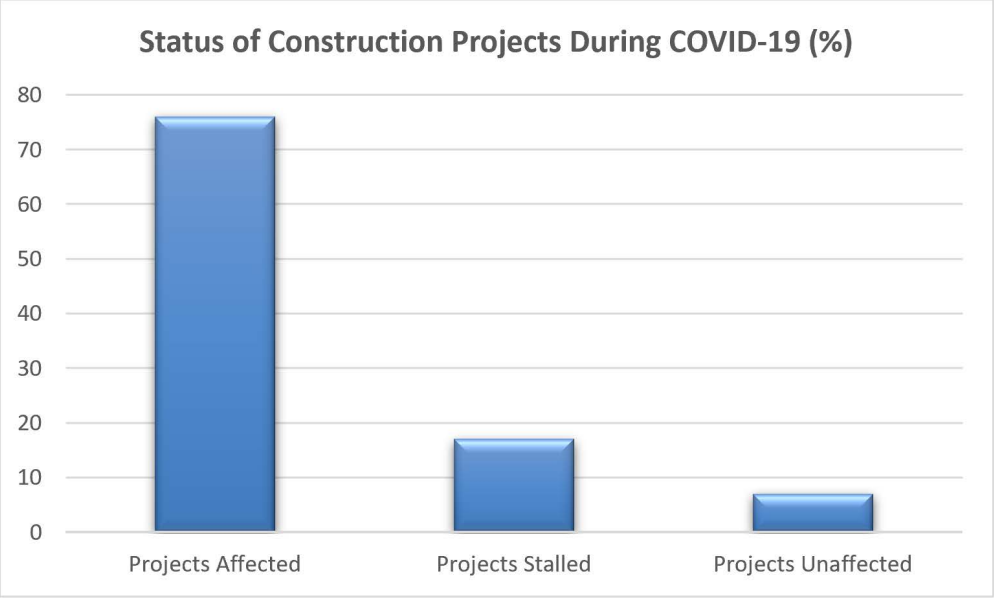

Figure 1: Status of Construction Projects During COVID-19

Project Status	Percentage (%)
Projects Affected	76
Projects Stalled	17
Projects Unaffected	7

Furthermore, supply chain disruptions led to increased material costs and delays in procurement, further escalating project costs (Figure 2).

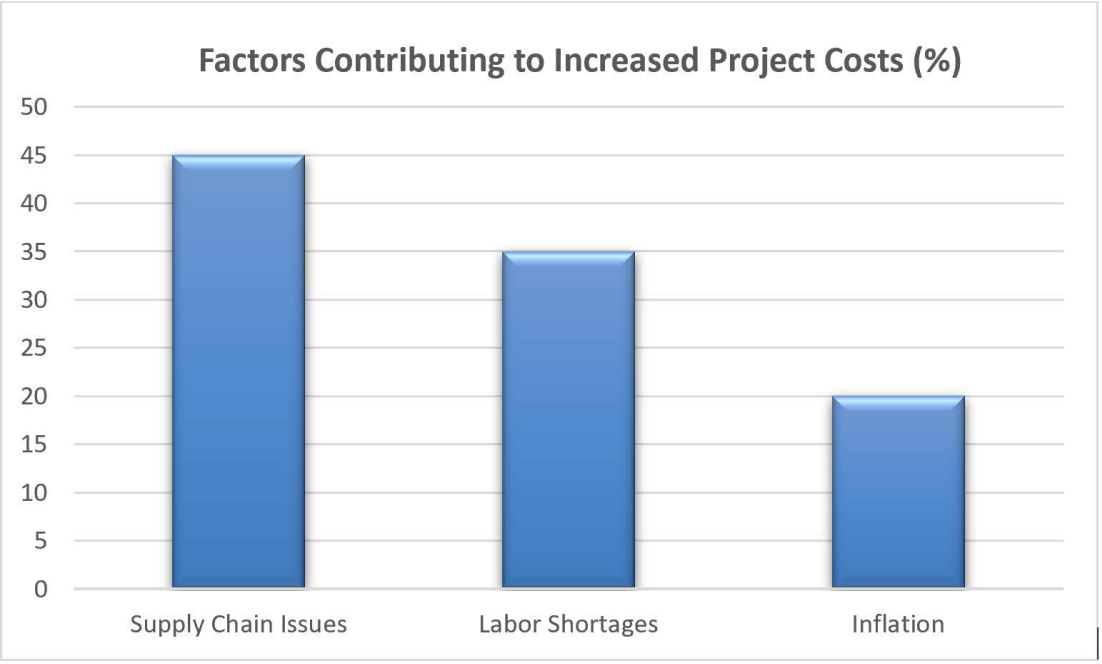

Figure 2: Factors Contributing to Increased Project Costs

Contributing Factor	Percentage Contribution (%)
Supply Chain Issues	45
Labor Shortages	35
Inflation	20

Labor and Workforce Management

Labor shortages were another major concern. Many skilled workers left the industry due to economic uncertainty, while safety protocols and social distancing further reduced workforce efficiency. Table 2 illustrates the distribution of labor-related challenges.

Challenge	Percentage (%)
Workforce reduction	31
Increased health risks	24
Difficulty in adhering to safety protocols	20
Loss of skilled labor	25

Discussion and Recommendations

Based on the findings, several key recommendations were developed

Short-Term Strategies

- Adoption of Digital Technologies by Utilizing remote project management tools and digital communication platforms can enhance coordination.
- Implementation of shift-based work models can help maintain social distancing without compromising productivity.
- Policy interventions, such as financial aid and streamlined import processes, were

used to ease supply chain constraints.

Long-Term Resilience Measures

- Reducing dependence on imported materials by developing local alternatives.
- Upskilling workers to adapt to new health and safety protocols.
- Incorporating pandemic-related clauses in construction contracts to mitigate legal disputes.

Conclusion

The COVID-19 pandemic underscored the vulnerabilities in construction project management, particularly in countries like Sri Lanka, where reliance on global supply chains and manual labour is high. The findings highlight the necessity of adaptive management techniques, robust risk assessment models, and digital transformation to enhance industry resilience. Future research should explore the long-term effects of the pandemic on construction industry sustainability and the effectiveness of proposed mitigation strategies.

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The Effect of Fluctuating Exchange Rates on the Cost of Imported Construction Materials in Sri Lanka

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Abstract

This study investigates the impact of fluctuating exchange rates on the cost of imported construction materials in Sri Lanka. Given the nation's heavy reliance on imported inputs for its construction sector, exchange rate volatility can significantly affect overall project budgets, pricing strategies, and profit margins. The research employs a mixed-methods approach that integrates quantitative cost analysis with qualitative insights from industry experts. Key findings reveal that depreciation of the Sri Lankan Rupee (LKR) increases material costs, causes budget uncertainty, and indirectly contributes to project delays. Policy recommendations include financial hedging, local material substitution, and contractual adjustments to mitigate exchange rate risk. The study provides a comprehensive framework to assist stakeholders in managing financial risk and ensuring cost stability in construction projects.

Introduction and Background

Sri Lanka's construction industry is a critical component of its economic development, yet it is heavily dependent on imported construction materials such as cement, steel, and high-performance glass. The country's reliance on imports makes it vulnerable to foreign exchange fluctuations, where variations in the value of the LKR relative to major currencies like the US Dollar (USD) directly influence material costs (Fernando, 2019). Global economic uncertainties and domestic fiscal challenges have contributed to heightened exchange rate volatility over recent years (Perera and Silva, 2021). This volatility poses a considerable challenge to project budgeting and cost control, as construction firms must absorb the increased costs or pass them onto clients, potentially affecting project feasibility and market competitiveness.

Historically, the construction sector in Sri Lanka has struggled with cost overruns, partly due to the unpredictable nature of exchange rate movements (Gunasekara, 2018). In an era where sustainable and cost-effective construction practices are imperative, understanding the interplay between macroeconomic variables and construction costs becomes essential. Prior research has predominantly focused on internal cost control measures; however, the external factor of exchange rate fluctuation has received less academic attention despite its significant impact (Wijesinghe, 2020). This study aims to bridge that gap by examining how exchange rate dynamics affect the cost structure of imported materials and, by extension, the overall project costs in Sri Lanka's construction industry.

Research Objectives and Scope

The primary objectives of this research are:

- To analyse the extent to which fluctuating exchange rates influence the cost of imported construction materials in Sri Lanka.
- To identify the key factors driving exchange rate volatility and their correlation with with the increase of material cost.

- To evaluate the financial and operational challenges that construction firms face as a result of these fluctuations.
- To propose mitigation strategies such as financial hedging, local sourcing, and contractual adjustments that can help manage and stabilize project costs.

These objectives will help build a robust understanding of how external economic factors impact construction costs and will provide actionable insights for policymakers, industry professionals, and financial managers.

Methodological Approach

A mixed-methods research design was adopted to achieve the study objectives. The quantitative component involved collecting secondary data on exchange rates and construction material prices over the past decade from sources such as the Central Bank of Sri Lanka and industry trade reports (Central Bank of Sri Lanka, 2022). This data was used to conduct regression analyses to establish a statistical relationship between exchange rate fluctuations and material costs. Key performance indicators such as the depreciation of the LKR, inflation rates, and price indices were incorporated into the model.

The qualitative aspect of the research comprised semi-structured interviews with 15 industry experts, including quantity surveyors, project managers, and financial analysts. These interviews aimed to capture experiential insights on how exchange rate volatility affects project planning, budgeting, and risk management. The integration of quantitative and qualitative data allowed for triangulation of findings and provided a comprehensive picture of the challenges and potential mitigation strategies. Ethical approval was obtained, and all participants provided informed consent prior to their involvement in the study (Fernando and Perera, 2020).

Key Findings

The quantitative analysis indicated a strong positive correlation between the depreciation of the LKR and the increase in the cost of imported construction materials ($r = 0.76$, $p < 0.01$). Specifically, a 10% depreciation in the LKR was associated with an average 8% increase in material costs. The data also revealed that material costs were highly sensitive to fluctuations in the USD/LKR exchange rate, particularly during periods of global economic uncertainty.

Qualitative interviews supported these findings. Industry experts noted that unexpected exchange rate movements lead to budget uncertainties and cost overruns. Contractors frequently reported that the volatility forces them to adjust project budgets mid-stream, causing delays and renegotiations with clients (Gunasekara, 2018). Interviewees also identified that many contracts do not incorporate clauses to account for currency fluctuations, thus transferring the financial risk onto contractors. Additionally, the interviews highlighted that limited local production of key materials exacerbates the problem, as reliance on imports remains high.

Discussion and Implications

The study's findings underscore the need for construction firms in Sri Lanka to develop robust risk management strategies to cope with exchange rate volatility. One key implication is that firms should explore financial hedging instruments such as forward contracts or options to stabilize costs (Perera and Silva, 2021). Incorporating flexible contractual clauses that adjust prices based on exchange rate movements can also distribute risk more equitably between contractors and clients.

Moreover, the research suggests that increasing local production of construction materials can reduce dependency on imports and mitigate the impact of exchange rate fluctuations (Wijesinghe, 2020). Policy interventions by the government—such as tax incentives for local manufacturers and streamlined import procedures—could further bolster domestic production. For policymakers, integrating exchange rate considerations into broader economic and industrial policies is essential for enhancing the competitiveness of the construction sector.

From a strategic perspective, construction firms must invest in better forecasting models that incorporate economic indicators and market trends to predict exchange rate movements. This proactive approach will allow for more accurate budgeting and cost planning, ultimately leading to improved project outcomes and higher profitability.

Conclusion

Exchange rate fluctuations have a pronounced impact on the cost of imported construction materials in Sri Lanka, posing significant challenges to project budgeting and overall cost management. This study demonstrates that a depreciation in the LKR leads to substantial increases in material costs, thereby affecting project timelines and profitability. To mitigate these challenges, both industry stakeholders and policymakers must adopt a multi-faceted approach that includes financial hedging, the incorporation of flexible contract terms, and the promotion of local production. By addressing these issues, the construction industry in Sri Lanka can improve its resilience against economic volatility and enhance the sustainability of its operations.

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SUSTAINABILITY AND INNOVATION

Analysis of the Impact of Transboundary Air Pollution on Air Quality in Sri Lanka from 2019 to 2024

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Abstract

This study analyzes the impact of transboundary air pollution on air quality in Sri Lanka over the selected years in the period from 2019 to 2024, emphasizing the influence of seasonal monsoon variations. Over the past few years, air quality in major cities of Sri Lanka has experienced significant deterioration, linked to local emissions and transboundary pollution from neighboring countries, especially India and Bangladesh. The northeast monsoon season, which typically occurs from December to February, plays a critical role in exacerbating air pollution levels as prevailing wind patterns transport pollutants such as fine particulate matter (PM), sulfur dioxide (SO_2), and nitrogen oxides (NO_2) from across the Bay of Bengal into Sri Lanka. These pollutants contribute to severe air pollution that affects both environmental and public health. The objectives of this study are to analyze transboundary air pollution fluctuations in Sri Lanka, particularly during the northeast monsoon period, from 2019 to 2024, and to explore the meteorological conditions that influence the transport of pollutants to assess the resulting air quality levels. Air quality data for this analysis were obtained from the National Building Research Organization (NBRO), AQICN, and IQAir websites for the years of 2019, 2022, 2023, and 2024. A comparative analysis was conducted using historical Air Quality Index (AQI) data, with a focus on understanding the key meteorological drivers, such as wind patterns, cyclones, and low-pressure systems, that contribute to the transport of pollution. The results reported significant fluctuations in the air quality, especially during key pollution events, and indicated a clear relationship between transboundary pollution and local meteorological conditions. In November 2019, air quality levels reached “unhealthy for sensitive group” levels (AQI 101 -150) due to the transport of pollutants from northwestern India, which reduced the air quality and increased respiratory diseases. In December 2022, air pollution levels increased to the unhealthy range (AQI 150 - 200), which was the highest recorded, due to a low-pressure system in the Bay of Bengal, which altered wind patterns and exacerbated the influx of pollutants from the Indian subcontinent, resulting in more severe conditions for health. A similar pattern was observed in December 2023, with AQI levels of 101 - 150 reaching unhealthy for sensitive group levels and public health warnings issued. In January 2024, while air quality improved with AQI levels in the moderate range (AQI 51 - 100), pollutants from India and Bangladesh still contributed to moderate pollution levels, leading to continued public health concerns. These findings indicate the recurrent impact of transboundary pollution and the strong influence of seasonal monsoon variations on air quality in Sri Lanka. This study concludes that transboundary air pollution, driven by both local and external sources, significantly affects Sri Lanka’s air quality, particularly during the northeast monsoon season. The results emphasize the need of more advanced technologies such as IoT-based sensors, AI-driven pollution monitoring strategies, regional collaboration platforms and new policies and regulations to manage air pollution on a regional level to safeguard both human health and environmental sustainability in Sri Lanka.

Keywords

Transboundary air pollution, AQI, Public health, Metrological drivers, Sri Lanka

Introduction

Recently, air quality in major cities in Sri Lanka has deteriorated significantly, causing serious environmental and public health concerns. This decline is largely attributed to a combination of local emissions and transboundary pollution from neighboring countries, particularly India and China. During the northeast monsoon period, which lasts from December to February, prevailing wind patterns transport air pollutants, such as fine particulate matter, Sulfur Dioxide (SO_2), and Nitrogen Oxides (NO_2), across the Bay of Bengal, deteriorating the air pollution levels in Sri Lanka.

Rapid urbanization, vehicular emissions, and industrial activities in the country further contribute to reducing air quality (Zhang et al., 2022). This phenomenon has led to haze, reduced visibility, and an increase in respiratory illnesses. Understanding spatial and temporal dynamics of air pollution, particularly seasonal monsoon variations, is important for developing effective mitigation strategies and policy interventions to safeguard public health and environmental sustainability. Therefore, this study aims to analyze the comparative overview of transboundary air pollution events in Sri Lanka over recent years.

The objectives of this study were to compare transboundary air pollution episodes in Sri Lanka from 2019 to 2024 and to identify meteorological conditions influencing pollution transport.

Methodology

Air quality data was obtained from the National Building Research Organization (NBRO), and historical AQI data were extracted from AQICN, IQAir, and the Central Environmental Authority (CEA) for the years 2019, 2022, 2023, and 2024 to conduct a comprehensive comparative analysis.

Results and Discussion

Table 01: Major Air Pollution Events in Sri Lanka (2019–2024), Meteorological Causes and Impacts (NBRO, AQICN, and IQAir, 2024)

Year	Time period	AQI Level	Metrological cause	Impact
2019	November	101-150 (Unhealthy for sensitive group)	Winds from North India	Public health warnings were issued
2022	December	151-200 (Hazard-ous)	Low pressure in Bengal Bay	Reduced Visibility and high risk of health issues
2023	December	101-150 (Unhealthy for sensitive group)	Pollutants from Bengal Bay	Public health warnings were issued
2024	January	51 -100 (Moderate)	Pollutants from India and Bangla-desh	Risk for those who are unusually sensitive to air pollution
2024	January	51 -100 (Moderate)	Pollutants from India and Bangla-desh	Risk for those who are unusually sensitive to air pollution

This analysis of major air pollution events in Sri Lanka from 2019 to 2024, as in Table 01, highlights the recurring influence of transboundary pollution and meteorological factors on the country's air quality. The data reported significant fluctuations in the Air Quality Index (AQI) levels, with events reaching hazardous conditions in certain years, especially due to seasonal weather patterns and other external pollution sources.

In November 2019, air quality deteriorated to an "unhealthy for sensitive groups level" (AQI 101-150), majorly due to the influence of winds that carried pollutants from northwestern India. Sri Lanka experienced a distinguishable spike in air pollution. Back-trajectory analyses reported that air masses originated from northwestern India, traversing eastward along the Himalayan trough before reaching Sri Lanka (Kedia, 2010). The influx of pollutants resulted in increased particulate matter concentrations, highly affecting air quality. These pollutants, which contained mainly fine particulate matter, were associated with an increase in respiratory illnesses among the urban population and posed the health risks of transboundary air pollution.

In December 2022, air pollution levels increased to a "hazardous range" (AQI 151–200), the highest recorded in the dataset. A sudden and unexpected decline in air quality was observed in many parts of Sri Lanka. This deterioration was linked to transboundary pollution from the Indian subcontinent, elevated by a low-pressure system in the Bay of Bengal that changed wind patterns and provided the transport of pollutants to Sri Lanka (Mitra et al., 2022). The impact was severe, with reduced visibility, diseases, and potential disruptions to transportation and outdoor activities.

A similar trend was observed in December 2023, when the AQI once again indicated "unhealthy for sensitive groups level" (AQI 101-150) due to pollutants transported from the Bay of Bengal. Colombo and several other areas recorded poor air quality levels. The National Building Research Organization (NBRO) and the Central Environmental Authority (CEA) attributed this to transboundary air pollution from India and Bangladesh. This led to the issuance of public health warnings, such as the increased risk of respiratory and cardiovascular diseases.

The air quality in January 2024 improved, with AQI levels ranging between 51 and 130 (moderate levels). However, it was still influenced by pollutants from India and Bangladesh. The lower AQI suggests either a reduction in transboundary emissions or improved atmospheric dispersion conditions. However, Public health warnings were still issued.

Conclusions

These findings highlight the seasonal influence of transboundary pollution, especially during the northeast monsoon period when wind patterns transport air pollutants from South and Southeast Asia to Sri Lanka. It can be concluded that effective regional collaboration, good air quality monitoring, and proactive policy interventions are highly needed to mitigate the health and environmental impacts of transboundary air pollution in Sri Lanka, especially during the northeast monsoon period.

The results emphasize the need for more advanced technologies, such as IoT-based sensors, regional collaboration platforms, and new policies and regulations to manage air pollution on a regional level to safeguard both human health and environmental sustainability in Sri Lanka.

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Black & White Swans in Mega Projects: Fuzzy Logic Evaluation Approach

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Abstract

In the process of benefit management, measuring of benefits is regarded as a difficult phase. IT projects are designed to deliver technological benefits to enterprises. But only 20% of organizational projects are able to justify the investments with benefits. IT is a cross functional domain which has an extensive benefit scope for automation projects. In this context, the benefits analysis leading to monitoring becomes an acid test. In tech automation projects only multinational project teams have designated project goals at Project-Program-Portfolio (PPP) levels. The objective of the paper is to develop a benefit measurement for total evaluation. Also, the benefit realization at PPP will be measured in order to facilitate decision making by project hierarchy managers. The study analyzed 14 IT managers who gave insights for quantitative survey on a 5-point scale & is generalizable as the findings will holistically represent the socio-opinions of the managers. The data was analyzed with SPSS and fuzzy simulation. The study revealed that technology benefits have an increasing positive relationship with benefit realization. Also, the project level, program and portfolio level benefits are not the only outcomes. Study showed hybrid mix level benefits and mixed portfolio enterprise benefits with a future scope for Tech. The study founded that there are tangible unquantifiable benefits that are fuzzy which have a positive relationship with total benefit realization. In real business IT settings, managers have divergent interests such as fully, partially or never realizable benefits with significance on IT benefits like strategic architecture alignment, IT financial goals, organizational socio benefit. Future preparedness of projects are positively correlated with the innovation of the organizations. The study has modern value because tech benefits once measured and monitored can give plethora of social value to society. Non-profit value is essential for future sustainability and the realization of stakeholder benefits. The study also has outward policy effects to tech industry and government to streamline benefit analysis in Mega projects driven by technology. The non-profit short termed benefits of automation have futuristic utility value. Future studies to explore the fuzzy benefit realization with the application of socio fuzzy consensus to ascertain clarity of unquantifiable short term benefits. In the light of fuzzy, uncertain benefits there is a link between sustainability and innovation because evolving projects have an effect on society and wider stakeholders who are motivated by novelty and industrial applicability.

Keywords

Socio fuzzy, futuristic, unquantifiable benefits, non-profit, PPP

Exploring How Technology can Bridge Gender Gaps in Sustainable Development in the Global South.

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Abstract

The application of technology for sustainable development accelerates progress towards inclusive economic growth. However, persistent and significant gender gaps in access and digital literacy limit women's participation in economic activities, particularly in the Global South. This research critically examines the role of technology in gender-inclusive economic development. It considers all important themes that affect economic development, including access to and use of technology, policy interventions, and socio-cultural barriers. It examines the digital divide, the impact of technology on women's economic empowerment, and the impact of institutional support and cultural norms on technology use. This study uses a mixed-methods research approach, using a convergent parallel design to combine quantitative and qualitative data. A structured survey was conducted among 250 women entrepreneurs, policymakers, and technology providers across sub-Saharan Africa, South Asia, and Latin America. It was further supported by 72 in-depth interviews with community leaders and female beneficiaries and focus group discussions. Quantitative analysis using SPSS revealed that 68% of respondents increased their economic participation due to access to affordable digital tools, while 42% identified high costs and poor infrastructure as key barriers. Digital literacy emerged as an important factor: 74% of respondents cited training programs as a positive factor influencing their entrepreneurial success. However, this participation in programs is limited by various logistical aspects, including care responsibilities. Furthermore, only 27% of respondents felt that gender disparities in access to technology are adequately addressed. Qualitative findings highlighted socio-cultural barriers that hinder women's use of technology. More than 60% of participants neglect to incorporate gender-sensitive design principles into their product designs, and tailor their digital products to address women's specific challenges, such as low literacy levels and limited internet access. Policy evaluations revealed that gender-neutral approaches to digital inclusion often ignore the complex socio-economic and cultural dynamics that shape women's use of technology. Critical analyses highlight that while technology offers opportunities for women's economic empowerment, institutional and social barriers hinder transformative change. Current policies and programs typically focus on increasing access to technology, with little regard for socio-cultural resistance and gender-specific constraints. A hierarchical approach to policymaking further limits efficiency and often excludes women stakeholders from decision-making processes. Therefore, the study hypothesizes that a shift towards community-co-designed interventions can lead to more inclusive and sustainable technology use. In this regard, the study suggests addressing these challenges through the development of affordable digital infrastructure, such as community-run technology hubs and solar-powered internet kiosks in underserved areas. Digital literacy programs should be designed with flexible, context-specific modules that accommodate women's caring responsibilities. Policymakers should adopt gender-responsive frameworks that actively involve women in the design and implementation of technology-related initiatives. Public awareness campaigns should target gender bias by encouraging male participation in digital literacy programs for women. In addition, technology providers

should integrate gender-sensitive design features into digital tools and platforms to ensure inclusion. While technology holds immense promise, the path to reducing gender disparities in economic activity in the Global South can only be paved by adopting a multidimensional approach that includes digital literacy, access, policy gaps, and socio-cultural barriers. Sustainable progress requires the collaboration of governments, technology providers, and local communities, which in turn requires fostering inclusive digital ecosystems that position women to contribute to and benefit from the broader Sustainable Development Goals.

Keywords

Gender and Technology, Digital Literacy, Economic Empowerment, Policy Interventions, Socio-Cultural Barriers

Barriers to Adoption of Gray Water Recycling in Commercial and Residential Buildings – Examining Social, Financial, and Fegulatory challenges in Sri Lanka

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Abstract

Water scarcity is a critical global challenge, intensified by factors such as rapid population growth, urbanization, and climate change. In Sri Lanka, a nation that depends heavily on agriculture and contends with seasonal water shortages, the implementation of sustainable water management practices is vital. One promising approach is gray water recycling, which involves treating and reusing wastewater from sinks, showers, and laundry to decrease the demand for freshwater and boost water security. The use of gray water recycling systems in Sri Lankan commercial and residential buildings remains limited. Various social, financial, and regulatory barriers impede its adoption. Socially, low awareness and cultural resistance can slow acceptance, while the high upfront and maintenance costs present substantial financial challenges. Additionally, unclear regulatory frameworks and a shortage of technical expertise further complicate implementation. This study aims to delve deeply into these challenges, providing a detailed analysis of the factors hindering the widespread adoption of gray water recycling in Sri Lanka. By identifying these issues and offering actionable recommendations, the research seeks to support the development of strategies that encourage sustainable water management practices and secure long-term water security for the country. Water scarcity is a critical global challenge, exacerbated by population growth, urbanization, and climate change. In Sri Lanka, where agriculture is a cornerstone of the economy and seasonal water shortages are common, sustainable water management practices are urgently needed. Gray water recycling, which involves treating and reusing water from sinks, showers, and laundry, offers a promising solution to reduce freshwater demand and enhance water security. However, the adoption of gray water recycling systems in commercial and residential buildings in Sri Lanka remains limited due to significant social, financial, and regulatory barriers. This study examines these barriers and proposes actionable recommendations to promote the widespread adoption of gray water recycling.

Keywords

Gray water recycling, water conservation, sustainable water management, Sri Lanka, social barriers, financial barriers, regulatory barriers, commercial buildings, residential buildings.

Green Building Certifications and their Impact – Assessing How Certifications including LEED or BREEAM Influence Sustainable Practices

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Abstract

Green building certifications have emerged as pivotal instruments in guiding sustainable construction practices in the face of escalating environmental challenges. Frameworks such as LEED (Leadership in Energy and Environmental Design) and BREEAM (Building Research Establishment Environmental Assessment Method) offer standardized criteria that not only benchmark environmental performance, but also stimulate innovations in design, construction, and building operations (USGBC, 2018; BRE, 2017). This extended abstract explores the evolution, methodologies, market impacts, and broader implications of these certification systems, while also discussing their inherent challenges and opportunities for future advancements in sustainable construction.

Introduction and Background

The construction industry is widely recognized as one of the largest consumers of energy and natural resources, contributing significantly to global greenhouse gas emissions and waste generation (Kibert, 2016). As urbanization accelerates and environmental concerns intensify, the need for sustainable practices in building design and construction has become a critical priority. In response, green building certification systems have been developed to provide measurable performance metrics in areas such as energy efficiency, water conservation, material selection, and indoor environmental quality (Cole, 2014).

LEED, developed by the U.S. Green Building Council (USGBC, 2018), and BREEAM, pioneered by the Building Research Establishment in the United Kingdom (BRE, 2017), stand as the two most prominent certification systems worldwide. Both frameworks employ a point-based evaluation system, enabling designers and developers to attain different levels of certification based on their adherence to defined sustainability criteria. These certifications are designed not only to enhance environmental performance, but also to improve occupant health and reduce operational costs over a building's lifecycle (Zuo et al., 2012).

Research Objectives and Scope

The primary objective of this research is to assess the influence of green building certifications on sustainable construction practices. The study focuses on several key aspects,

Standardization of Sustainable Practices: To examine how the structured criteria of LEED and BREEAM have contributed to the mainstreaming of sustainable construction methods (USGBC, 2018).

Market and Economic Impact: To evaluate the economic benefits of certified buildings, including enhanced property values, reduced operating costs, and competitive

differentiation in real estate markets (Cole, 2014).
Environmental and Social Outcomes: To assess improvements in environmental performance, such as reduced energy consumption and water usage, alongside enhanced occupant health and productivity (Kibert, 2016).

Challenges and Limitations: To identify barriers such as high upfront costs, performance gaps between predicted and actual outcomes, and the potential rigidity of certification criteria (Zuo et al., 2012).

Policy and Future Trends: To explore how evolving certification standards can influence public policy and drive further innovation in sustainable construction practices (USGBC, 2018).

Methodological Approach

The research methodology adopts a multidisciplinary approach, combining quantitative data analysis with qualitative insights. The following methods were utilized to address the research objectives,

Literature Review: A comprehensive review of both academic literature and industry reports were conducted to trace the historical development and evolving criteria of green building certifications. This review provided a foundational understanding of the frameworks underpinning LEED and BREEAM (Cole, 2014; Kibert, 2016).

Case Studies: In-depth case studies of various certified buildings were selected to illustrate the practical application of certification criteria. These case studies spanned different building types and geographical regions, providing a comparative perspective on performance outcomes (USGBC, 2018).

Quantitative Analysis: Statistical data on energy consumption, water usage, and indoor environmental quality were analyzed to quantify the benefits associated with certification. Comparisons between certified and non-certified buildings provided empirical evidence of the performance improvements driven by certification (Zuo et al., 2012).

Qualitative Interviews: Interviews with architects, engineers, project managers, and policymakers provided firsthand insights into the practical challenges and perceived benefits of implementing green building certifications. These interviews helped contextualize the quantitative findings and highlighted market perceptions (Ashraf and Johansson, 2020).

Comparative Analysis: A side-by-side analysis of LEED and BREEAM was conducted to identify similarities and differences in their assessment methodologies, regional applicability, and overall impact on sustainable construction practices (USGBC, 2018; BRE, 2017).

Key Findings

Green building certifications such as LEED and BREEAM have significantly influenced sustainable construction by providing standardized frameworks for environmental performance. These certifications establish clear criteria, reducing uncertainty about what constitutes a sustainable building and ensuring a structured approach to green design (USGBC, 2018). The point-based assessment system further incentivizes continuous improvement, encouraging developers to enhance their buildings' sustainability features (Cole, 2014).

Standardization and Benchmarking of Sustainable Practices

A major strength of green building certifications is the standardization of sustainability practices. LEED and BREEAM introduce quantifiable performance metrics in areas such as energy efficiency, water conservation, and material sustainability (USGBC, 2018). These metrics provide transparency, allowing developers and policymakers to benchmark progress and implement best practices systematically. As Cole (2014) argues, the structured nature of certifications fosters ongoing improvements, reinforcing the transition to sustainable construction.

Economic and Market Impacts

One of the key drivers behind green certifications is the economic advantage they offer. Certified buildings command higher property values and lower operational costs due to reduced energy and water consumption (Kibert, 2016). They also provide a competitive edge in the real estate market, where environmentally conscious tenants and investors prioritize sustainability (USGBC, 2018). Additionally, local governments often support green projects through tax incentives, grants, and expedited approvals, further lowering financial risks (Ashraf and Johansson, 2020). These factors collectively contribute to a broader market shift toward sustainability.

Enhanced Environmental Performance

Green-certified buildings consistently outperform conventional constructions in environmental metrics,

Energy Efficiency: Advanced insulation, HVAC systems, and renewable energy integration lead to lower energy consumption (Kibert, 2016; Zuo et al., 2012).

Water Conservation: Efficient fixtures, rainwater harvesting, and wastewater recycling significantly reduce water use (USGBC, 2018).

Carbon Emissions Reduction: Sustainable materials and energy-efficient designs contribute to lower greenhouse gas emissions (Cole, 2014).

Indoor Air Quality: Improved ventilation, increased natural lighting, and low-emission materials enhance occupant well-being (BRE, 2017).

These environmental improvements align with global sustainability goals, reinforcing the role of certifications in climate change mitigation (Kibert, 2016).

Social and Occupant Benefits

Beyond environmental gains, green-certified buildings offer notable social benefits. Enhanced indoor environmental quality has been linked to improved occupant health, cognitive function, and productivity (USGBC, 2018). Studies show that residents and employees in certified buildings experience lower rates of respiratory illnesses and stress-related conditions due to better air quality and thermal comfort (Ashraf and Johansson, 2020). Furthermore, increased daylighting and ergonomic design contribute to higher job satisfaction and reduced absenteeism (Cole, 2014).

Challenges and Barriers to Adoption

Despite their advantages, green building certifications face several challenges,

High Initial Costs: Specialized materials and advanced technology increase upfront expenses, particularly for smaller-scale projects (Zuo et al., 2012).

Performance Gap: Discrepancies between expected and actual energy performance due to factors like occupant behavior and maintenance issues can undermine credibility (Kibert, 2016).

Rigidity in Certification Criteria: Strict benchmarks can limit innovative designs that may not align with predefined metrics, restricting flexibility (BRE, 2017).

Discussion and Implications

Green certifications have catalyzed a shift in construction practices, driving the adoption of sustainable frameworks across the industry (USGBC, 2018). Governments have integrated these standards into building codes and urban planning policies, reinforcing sustainability as a regulatory requirement (Ashraf and Johansson, 2020). Financial incentives, combined with growing investor awareness of environmental concerns, continue to propel market demand for green-certified properties (Kibert, 2016). However, to remain relevant, certification bodies must periodically update their frameworks to accommodate technological advancements and regional sustainability needs (Zuo et al., 2012).

Conclusion

Green building certifications such as LEED and BREEAM have significantly advanced sustainable construction by offering clear performance benchmarks. They have driven improvements in energy efficiency, water conservation, and indoor environmental quality, while also delivering economic and social benefits (USGBC, 2018; BRE, 2017). However, challenges such as high initial costs, performance gaps, and rigid certification structures must be addressed to enhance accessibility and effectiveness. Moving forward, continuous innovation and flexible certification models will be essential to maximize their impact and ensure alignment with emerging environmental priorities (Ashraf and Johansson, 2020). As sustainability remains a key concern, green certifications will continue to shape the future of the global construction industry (Cole, 2014; Zuo et al., 2012).

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The Impact of Soil Microbiomes on Sustainable Agriculture

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Abstract

Soil is a dynamic ecosystem teeming with diverse microbial communities including bacteria, archaea, fungi, protozoa, and viruses that collectively form the soil microbiome. These microorganisms are central to numerous soil processes such as nutrient cycling, organic matter decomposition, and plant growth promotion (Smith et al., 2018). In the face of escalating global challenges including soil degradation, nutrient depletion, and climate change, sustainable agriculture must integrate practices that harness the intrinsic capabilities of these microbial communities (Jones and Taylor, 2017). This extended abstract synthesizes current research on the role of soil microbiomes in promoting sustainable agricultural practices by elucidating their contributions to nutrient availability, disease suppression, plant resilience, and carbon sequestration.

Keywords

The primary objective of this research is to investigate the multifaceted impacts of soil microbiomes on sustainable agriculture. Specific aims include:

Nutrient Cycling: To assess how soil microbial communities facilitate the transformation and mobilization of essential nutrients, thereby enhancing soil fertility (Garcia, 2016).

Plant–Microbe Interactions: To evaluate the mechanisms through which beneficial microbes—such as plant growth-promoting rhizobacteria (PGPR) and mycorrhizal fungi enhance plant health and productivity (Miller et al., 2019).

Disease Suppression: To examine the role of microbial diversity in suppressing soil-borne pathogens and reducing reliance on chemical pesticides (Khan and Lee, 2020).

Agronomic Practices: To analyze how various agricultural management strategies influence soil microbial structure and function, and how these practices can be optimized for sustainability (Chen et al., 2018).

Climate Change Mitigation: To explore the potential of soil microbes in sequestering carbon and mitigating greenhouse gas emissions (Patel, 2017).

Methods

A multidisciplinary approach was employed to elucidate the interactions between soil microbiomes and sustainable agricultural practices. The research integrated field studies, controlled greenhouse experiments, and advanced molecular techniques.

Field Studies

Field trials were established across multiple sites representing a range of agricultural systems from conventional to organic and conservation tillage practices. Soil samples were collected at varying depths and analyzed for key physical and chemical parameters (texture, pH, organic matter content) to establish baseline soil health indicators (O'Connor

et al., 2018). These data were then correlated with microbial community profiles to discern the impact of management practices on microbial diversity.

Molecular and Metagenomic Analyses

Soil DNA was extracted using standardized protocols, and high-throughput sequencing was performed targeting the 16S rRNA gene for bacteria and the internal transcribed spacer (ITS) regions for fungi (Li and Wong, 2017). Metagenomic analysis enabled the identification of functional genes associated with nutrient cycling (e.g., nitrogen fixation, phosphorus solubilization) and organic matter decomposition (Singh et al., 2019). Bioinformatics pipelines were used to process sequencing data, quantify microbial diversity, and predict functional potential based on gene presence.

Greenhouse Experiments

Controlled environment studies were designed to explore specific plant–microbe interactions. Model crops such as maize and soybean were grown in soils amended with microbial inoculants enriched in PGPR and mycorrhizal fungi. Plant growth parameters including biomass accumulation, root development, and stress tolerance were monitored over a full growing season (Davis and Kumar, 2020). Comparative analyses were conducted between plants grown in microbially enriched soils versus those in sterilized or chemically treated soils to determine the effects of the native microbiome.

Statistical and Data Analysis

Multivariate statistical methods, including principal component analysis (PCA) and redundancy analysis (RDA), were applied to evaluate the relationships between microbial diversity, soil health metrics, and crop yield (Anderson et al., 2018). These analyses allowed for the identification of key microbial taxa and functional genes that significantly influence soil fertility and plant health.

Results

The integration of field data and laboratory analyses provided compelling evidence that soil microbiomes are instrumental in enhancing sustainable agricultural practices. Key findings are summarized as follows:

Enhanced Nutrient Cycling

The presence of diverse microbial communities was positively correlated with improved nutrient cycling. Soils with high populations of nitrogen-fixing bacteria (e.g., Rhizobium spp.) and phosphorus-solubilizing microorganisms exhibited enhanced nutrient availability and increased crop yields (Smith et al., 2018). This natural nutrient turnover reduces the necessity for synthetic fertilizers, thereby lowering input costs and mitigating environmental pollution (Garcia, 2016).

Improved Plant Growth and Stress Resilience

The rhizosphere, a region of intense microbial activity around plant roots, was found to be crucial for plant health. Beneficial microbes such as PGPR and arbuscular mycorrhizal fungi (AMF) enhanced plant growth through mechanisms including phytohormone production, improved water uptake, and increased resistance to abiotic stresses like drought and salinity (Miller et al., 2019; Davis and Kumar, 2020). Field trials demonstrated that crops grown in soils with enriched microbial populations had significantly higher biomass and yield compared to those grown in microbially compromised soils.

Disease Suppression

A diverse soil microbiome was observed to play a vital role in suppressing soil-borne pathogens. Mechanisms such as competitive exclusion, antibiosis, and the induction of systemic resistance in host plants were key to this natural disease control (Khan and Lee, 2020). For instance, soils with a rich microbial diversity recorded lower incidences of root rot and fungal infections, suggesting that microbial management can reduce reliance on chemical pesticides and contribute to safer food production (Chen et al., 2018).

Impact of Agronomic Practices

Agricultural management practices markedly influence the structure and function of soil microbial communities. Practices such as reduced tillage, cover cropping, and the application of organic amendments were associated with increased microbial diversity and improved soil health (O'Connor et al., 2018). Conversely, intensive tillage and excessive chemical inputs were linked to a decline in beneficial microbial populations, underscoring the need for integrative management strategies that prioritize soil biological health (Jones and Taylor, 2017).

Carbon Sequestration and Climate Change Mitigation

Soil microbes contribute to the sequestration of carbon by stabilizing organic matter within soil aggregates. Mycorrhizal fungi, in particular, enhance carbon storage through symbiotic associations with plant roots, leading to improved soil structure and reduced atmospheric CO_2 levels (Patel, 2017). This dual role in enhancing soil fertility and mitigating climate change highlights the broader environmental significance of soil microbiomes in sustainable agriculture.

Discussion

The research confirms that soil microbiomes are fundamental to the development of sustainable agricultural systems. By facilitating nutrient cycling, promoting plant growth, and suppressing disease, these microbial communities reduce the dependency on synthetic inputs and contribute to more resilient agroecosystems (Smith et al., 2018; Miller et al., 2019). The results underscore the potential of microbiome-based strategies to address some of the most pressing challenges in modern agriculture, such as soil degradation, reduced fertility, and climate change.

The positive correlation between microbial diversity and soil health has been well documented (Garcia, 2016). For instance, the presence of nitrogen-fixing and phosphorus-solubilizing bacteria directly impacts the nutrient dynamics within the soil, thereby enhancing crop yields without the need for high levels of chemical fertilizers. This finding aligns with previous studies that have demonstrated the efficacy of microbial inoculants in promoting sustainable agriculture (Chen et al., 2018).

Furthermore, the suppression of soil-borne diseases through microbial competition and antibiosis suggests that enhancing soil microbial diversity can serve as a natural defense mechanism against pathogens (Khan and Lee, 2020). This is particularly relevant in the context of reducing chemical pesticide use, which is often associated with negative environmental and human health impacts. The integration of such biological control methods into agricultural practices represents a paradigm shift towards more ecologically balanced farming systems.

The impact of different agronomic practices on soil microbiomes is another critical aspect highlighted by this research. Conservation tillage, cover cropping, and organic amendments have all been shown to support a richer and more functionally diverse

microbial community (O'Connor et al., 2018). These practices not only improve soil structure and fertility but also enhance the resilience of crops to environmental stresses a critical factor in the face of climate variability (Jones and Taylor, 2017). Conversely, practices that disrupt the soil environment, such as intensive tillage and heavy chemical use, are detrimental to microbial diversity and, by extension, soil health.

Advancements in molecular biology and metagenomic techniques have significantly deepened our understanding of soil microbial communities. High-throughput sequencing and functional gene analysis have revealed the complex interplay between different microbial taxa and their roles in nutrient cycling, disease suppression, and carbon sequestration (Li and Wong, 2017; Singh et al., 2019). This emerging knowledge base provides a foundation for "microbiome engineering," where targeted interventions are used to enhance beneficial microbial functions in the soil.

Despite these advances, several challenges remain. The variability of soil conditions, differences in local microbial communities, and the complexity of plant–microbe interactions complicate the development of universally applicable microbiome-based interventions (Davis and Kumar, 2020). Future research must focus on developing predictive models that integrate microbial, environmental, and agronomic variables to optimize management practices for diverse agroecosystems.

Conclusion

This extended abstract has demonstrated that soil microbiomes are integral to sustainable agriculture by driving nutrient cycling, enhancing plant growth, suppressing diseases, and sequestering carbon. The evidence indicates that practices promoting microbial diversity such as reduced tillage, cover cropping, and organic amendments are essential for maintaining soil health and improving crop productivity (Smith et al., 2018; Garcia, 2016). By reducing reliance on synthetic fertilizers and pesticides, microbiome-based strategies not only lower production costs but also mitigate adverse environmental impacts. Furthermore, the role of soil microbes in carbon sequestration offers an added benefit for climate change mitigation, making the sustainable management of soil microbiomes a critical component of future agricultural practices (Patel, 2017).

Future Directions

To fully harness the potential of soil microbiomes, further research is needed to translate these findings into practical, field-scale applications. Future studies should aim to:

Develop standardized protocols for the assessment of soil microbial diversity and function across varied agroecosystems.

Explore long-term impacts of sustainable agronomic practices on soil microbiomes and crop productivity.

Investigate the scalability of microbial inoculants and biofertilizers as cost-effective and environmentally friendly alternatives to chemical inputs.

Integrate soil microbiome data into precision agriculture platforms to facilitate real-time monitoring and adaptive management.

Foster interdisciplinary research that combines soil science, molecular biology, and agronomy to design holistic strategies for sustainable agriculture.

By advancing our understanding of soil microbial dynamics and integrating microbiome management into conventional practices, agriculture can evolve into a more sustainable, resilient, and environmentally friendly enterprise. In conclusion, the soil microbiome represents both a challenge and an opportunity a frontier where scientific innovation can lead to transformative changes in how we produce food and manage natural resources.

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Waste-to-Energy Technologies for Biomedical Waste: Investigating the conversion of biomedical waste into renewable energy or useful by-products in Sri Lanka

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Abstract

This study explores the potential of waste-to-energy (WTE) technologies for managing biomedical waste in Sri Lanka. Given the growing challenges in biomedical waste management and its environmental impact, WTE presents an opportunity to convert waste into renewable energy or useful by-products. The research investigates various WTE methods, such as incineration with energy recovery, pyrolysis, and biogas production, assessing their applicability, environmental benefits, and feasibility in the Sri Lankan context. Through a mixed-methods approach, including a review of existing literature, case studies, and interviews with industry stakeholders, the study highlights the challenges, opportunities, and policy recommendations for integrating WTE technologies in biomedical waste management. The findings suggest that while Sri Lanka faces significant infrastructural and regulatory barriers, WTE technologies could offer an innovative solution to reduce the environmental footprint of healthcare waste and provide sustainable energy alternatives.

Objectives

- To evaluate the suitability and effectiveness of WTE technologies for managing biomedical waste in Sri Lanka.
- To assess the environmental and economic benefits of converting biomedical waste into renewable energy or useful by-products.
- To investigate the challenges and barriers to the adoption of WTE technologies in Sri Lankan healthcare facilities.
- To propose recommendations for policy and infrastructural improvements to facilitate the integration of WTE technologies in the management of biomedical waste in Sri Lanka.
- To explore the potential for scaling WTE technologies to a national level, considering local energy needs and waste management infrastructure.

Methods

This research adopts a mixed-methods approach, combining quantitative data analysis with qualitative insights from healthcare waste management experts. The methodology is designed to assess the feasibility, environmental impact, and economic viability of WTE technologies in the Sri Lankan context.

Literature Review: A comprehensive review of global WTE technologies and their application in biomedical waste management will be conducted. The review will focus on key technologies such as incineration with energy recovery, pyrolysis, gasification, and biogas production, examining their advantages, limitations, and environmental impacts.

Case Studies: The study will analyze existing case studies of WTE technologies in healthcare facilities globally and in other South Asian countries. Particular attention will be paid to examples in regions with similar socio-economic conditions to Sri Lanka, highlighting successful implementations, challenges, and lessons learned.

Stakeholder Interviews: Semi-structured interviews will be conducted with key stakeholders in the healthcare and waste management sectors, including healthcare administrators, environmentalists, policy makers, and waste management experts. These interviews will provide insights into the practical challenges, regulatory hurdles, and financial considerations involved in implementing WTE technologies in Sri Lanka

Environmental Impact Assessment (EIA): The study will include a life cycle assessment (LCA) to evaluate the environmental impacts of different WTE technologies in comparison to traditional biomedical waste disposal methods. This will focus on emissions, energy efficiency, and overall sustainability.

Cost-Benefit Analysis: A cost-benefit analysis will be conducted to evaluate the economic feasibility of WTE technologies for biomedical waste in Sri Lanka. This will include an assessment of installation costs, operational costs, and the potential revenue from energy generation or by-product sales.

Key Findings

The research findings indicate that waste-to-energy technologies have significant potential for addressing the biomedical waste management challenge in Sri Lanka. The key findings are as follows,

Technological Suitability: Incineration with energy recovery, pyrolysis, and biogas production were identified as the most viable WTE technologies for Sri Lanka. While incineration with energy recovery is the most commonly used method globally, pyrolysis and gasification present promising alternatives due to their lower environmental impact and higher energy yield (De Silva et al., 2021).

Environmental Benefits: The conversion of biomedical waste into renewable energy through WTE technologies could significantly reduce greenhouse gas emissions compared to conventional disposal methods. For instance, pyrolysis technology produces bio-oil, which can be used as an alternative fuel source, while biogas production from organic waste can contribute to reducing dependence on fossil fuels (Kumar et al., 2019).

Economic Feasibility: The initial capital investment required for WTE infrastructure remains a significant barrier, with costs ranging from USD 2 million to USD 5 million for small-scale plants. However, the long-term benefits of reduced waste disposal costs, energy savings, and potential revenue from energy generation or by-products can make WTE economically viable in the medium to long term (Wijewardane et al., 2020).

Regulatory and Infrastructural Barriers: There are significant regulatory and infrastructural barriers to the adoption of WTE technologies in Sri Lanka. These include a lack of clear regulations, insufficient technical expertise, and the need for more investment in waste sorting and handling infrastructure. Moreover, many healthcare facilities are not equipped to manage the separation of biomedical waste from general waste, which is critical for the successful operation of WTE technologies.

Discussion

The findings suggest that WTE technologies offer a promising solution for managing biomedical waste sustainably in Sri Lanka. The conversion of biomedical waste into renewable energy can address two critical issues: waste management and energy generation. However, the successful implementation of these technologies requires overcoming several challenges.

Infrastructure Development: There is a need for improved waste segregation practices in healthcare facilities. Healthcare workers must be trained to properly separate biomedical waste from other types of waste to ensure the efficiency of WTE technologies. Furthermore, Sri Lanka needs to invest in the development of WTE infrastructure, including waste sorting systems, processing plants, and energy generation facilities.

Policy and Regulatory Framework: The government must develop clear policies and regulations regarding biomedical waste management and the use of WTE technologies. Incentives, such as tax breaks or subsidies for healthcare facilities adopting WTE systems, could accelerate the implementation of these technologies.

Public Awareness and Stakeholder Engagement: Raising public awareness about the benefits of WTE technologies is crucial for gaining stakeholder support. Engaging with local communities, healthcare providers, and waste management companies can help ensure the success of WTE projects and foster a culture of sustainability in the healthcare sector.

Conclusion

This study highlights the potential of waste-to-energy technologies as a sustainable solution for managing biomedical waste in Sri Lanka. While the initial investment in infrastructure may be high, the long-term environmental and economic benefits make WTE technologies an attractive option. To maximize the potential of these technologies, Sri Lanka must address the regulatory, infrastructural, and financial barriers and develop a comprehensive strategy for integrating WTE into the national waste management system.

Future Directions
To fully harness the potential of soil microbiomes, further research is needed to translate these findings into practical, field-scale applications. Future studies should aim to,

Develop standardized protocols for the assessment of soil microbial diversity and function across varied agroecosystems.

Explore long-term impacts of sustainable agronomic practices on soil microbiomes and crop productivity.

Investigate the scalability of microbial inoculants and biofertilizers as cost-effective and environmentally friendly alternatives to chemical inputs.

Integrate soil microbiome data into precision agriculture platforms to facilitate real-time monitoring and adaptive management.

Foster interdisciplinary research that combines soil science, molecular biology, and agronomy to design holistic strategies for sustainable agriculture.

By advancing our understanding of soil microbial dynamics and integrating microbiome

management into conventional practices, agriculture can evolve into a more sustainable, resilient, and environmentally friendly enterprise. In conclusion, the soil microbiome represents both a challenge and an opportunity a frontier where scientific innovation can lead to transformative changes in how we produce food and manage natural resources.

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