BCAS CAMPUS
BRITISH COLLEGE OF APPLIED STUDIES

8th iNTERNATIONAL CONFERENCE ON MULTIDISCIPLINARY RESEARCH 2023

BCAS International Conference on

# Multidisciplinary Research

## The Next Frontier:
## Emerging Technologies for Global Well-being

ISSUE 08 - DECEMBER 2023

## Building Careers – Transforming Lives

## Vision

To become the premier private university in the region

## Mission

Produce quality human resources with ethics and social responsibility, having innovative thinking and analytical skills to serve humanity

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# iCMR

## 8th INTERNATIONAL CONFERENCE ON

# MULTIDISCIPLINARY RESEARCH 2023

## THE NEXT FRONTIER:

## Emerging Technologies for Global Well-being

20th December 2023 (Wednesday)

8.30 am to 5.00 pm

@ BCAS Auditorium
Colombo 03

ISSUE 08 - DECEMBER 2023

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# BCAS CAMPUS

Established in 1999, British College of Applied Studies (popularly known as BCAS Campus) has rapidly grown into a leading educational provider in Sri Lanka with a large number of students more than 3,500. BCAS Campus has strong international collaboration, especially, Solent University Southampton (UK), Oxford Brookes University (UK) and Pearson (BTEC) UK.

Besides the main campus in Colombo (City Campus), BCAS Campus has branches in other cities in Sri Lanka, namely, Kandy, Jaffna and Kalmunai.

Having won 18 awards nationally & internationally, the institution is highly esteemed for its exceptional quality, international recognition and market relevant training. To top it all, BCAS Campus was selected as the First of the Five Top higher education providers in Sri Lanka in 2013 by an independent survey conducted by an organization hired by Sri Lanka's pioneering business magazine LMD. Currently more than 3,500 students follow their chosen courses of study at BCAS Campus - Quantity Surveying, IT, Law, Business Management, Civil Engineering, Biomedical Science, Software Engineering, Cyber Security, Accounting & Finance, Tourism and Hospitality management and Project Management etc . These courses are delivered at various level including foundations, HND, Degree as well as at Masters.

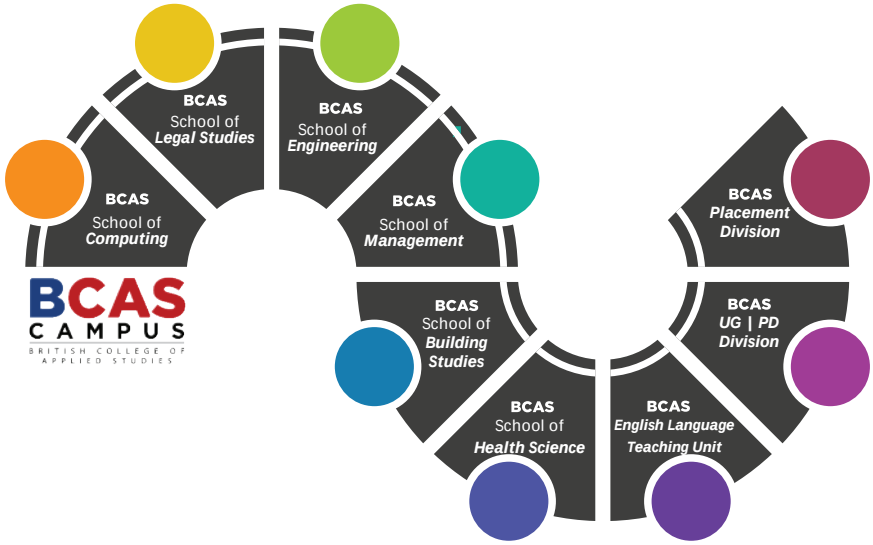
***Building Careers - Transforming Lives***

# BCAS in Brief

| | |
|---|---|
| **1999** | • Founded as IT/English training institute in Kandy |
| **2000** | • BCAS Placement division, placed the 1st batch of students to UK institutions. |
| **2001** | • Established 1st BCAS Centre in Colombo |
| **2002** | • Setup the main branch in Colombo<br>• Launched BTEC HND in IT/Computing |
| **2004** | • Vocational Courses in Construction, placed students in Industry.<br>• MoU with UK Colleges and Universities<br>• Expanded Kandy Campus /launched HND Computing /IT |

| | |
|---|---|
| **2005** | • Launched BTEC HND in QS<br>• Launched Vocational Programme – 'CAD and Building Studies' |
| **2006** | • Articulation agreement with a UK University for students' progression<br>• Launched Vocational Programme – 'Teacher Training' |
| **2007** | • 1st batch of students transferred to Uni of Wolverhampton( UoW)<br>• Established HND QS Centre in Dehiwala Campus |
| **2008** | • BTEC HND in Business Management |
| **2009** | • BTEC HND in Electrical / Electronic (Telecom)<br>• BTEC HND in Law |
| **2010** | • QS Top-Up Degrees in Dehiwala Campus - Bsc (Hons) QS- UoW |
| **2011** | • BTEC HND in – Biomedical Science - UoW<br>• Established Batti Campus<br>• EDEXCEL UK Award - Fastest/Most Outstating BTEC HND Centre<br>• ISO 9001 – 2008 Certified |
| **2012** | • BM Top-Up Degrees in City Campus - BA (BM) - UoW<br>• LLB Top-Up Degrees in City Campus - LLB - UoW<br>• Established Wayamba Campus<br>• MBA – Launched in City Campus - UoW |
| **2013** | • BTEC Level-7 Strategic Management – MBA Pathway- UoW<br>• BTEC HND – Civil Engineering<br>• Recognized by LMD Magazine as the "No.1 Private Education Provider |
| **2014** | • Established Kalmunai Campus |
| **2015** | • MSc Construction Project Management |
| **2017** | • Partnership with University of East London<br>• Launched Top-up Degree in Civil Engineering in Colombo |
| **2018** | • Partnership with Solent University in UK |
| **2019** | • Launched Global MBA and other Top-up Degrees in Colombo and Kandy |
| **2020** | • Partnership with Oxford Brookes University in UK<br>• Launched Top-up Degrees in Jaffna |

# Divisions / Academic Schools

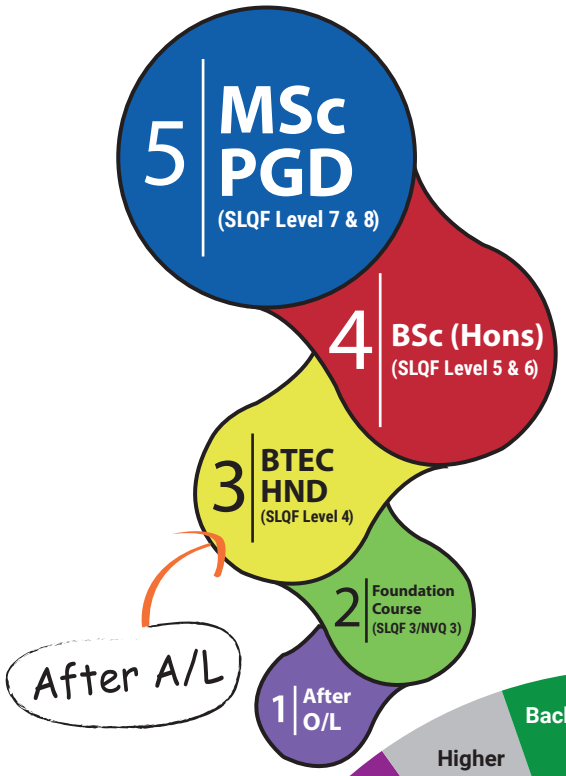



# Quality Management Structure

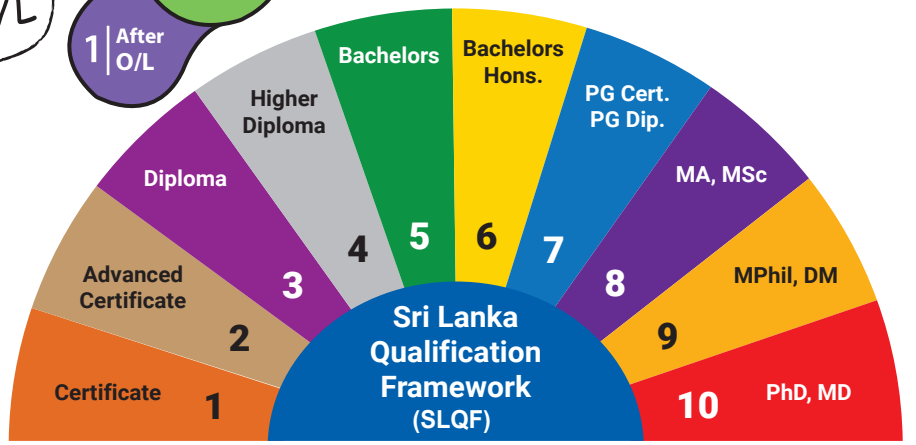
Board of Management → Academic Syndicate → Board of Examination

# Service Divisions

| | | |
|---|---|---|
| Student Placement & Study Abroad Division (Located in BCAS) | PAC Asia | Student Counselling Division (Located in BCAS) |




# Qualification Frameworks




| Sri Lankan National | | | BTEC/UK | |
|---|---|---|---|---|
| | SLQF | NVQ - | BTEC-QCF (UK) | |
| Doctorial Degree, MD | SLQL-10 | | QCF-L8 | PhD/DPhil |
| M.Phil., Masters (Research) | SLQL-9 | | QCF-L7 | Master's degrees |
| Master (Taught + Research) | SLQL-8 | | | |
| Master (Taught), PG-D, PG-C | SLQL-7 | | | |
| Honours Bachelor | SLQL-6 | | QCF-L6 | Bachelor's degrees, eg BA, BSc |
| Bachelor Degree | SLQL-5 | NVQ-7 | | |
| High Diploma | SLQL-4 | NVQ-6 | QCF-L5 | BTEC HNDs (Higher National Diplomas) |
| Diploma | SLQL-3 | NVQ-5 | QCF-L4 | BTEC HNCs (Higher National Certificates) |
| Advanced Certificate | SLQL-2 | NVQ-4 | QCF-L3 | BTEC National Diploma |
| Certificate | SLQL-1 | NVQ-2, 3 | | BTEC National Extended Diploma |

# Quality Assurance

ISO 9001:2015
Member of SN Registrars (Holdings) Ltd
UKAS MANAGEMENT SYSTEMS 8327

QAA
Quality Assurance Agency UK

Pearson

# Approval, Recognition Partnership

SOLENT UNIVERSITY SOUTHAMPTON

OXFORD BROOKES UNIVERSITY

GENERAL SIR JOHN KOTELAWALA DEFENCE UNIVERSITY

Pearson

Maldives Qualifications Authority
www.mqa.gov.mv

**2015** RELEASE

**2016** RELEASE

**2017** RELEASE

# BCAS CAMPUS

## 8TH NTERNATIONAL CONFERENCE ON MULTIDISCIPLINARY RESEARCH

# iCMR 2023

**2022** RELEASE

**2018** RELEASE

**2019** RELEASE

**2020** RELEASE

# INTERNATIONAL & LOCAL AWARDS

Gold Award
Pearson, UK

**2022**

Gold Award
Pearson, UK

**2019**

Excellence in
Training Award

Overall Award based on
results based training
Asia Pacific HRM Congress

**2019**

> Best Employer Brand Award

> Outstanding Contribution
to the Cause of Education

> Award for Excellence in Training

World HRD Congress
13th Employers Branding Award
Le Meridien, Singapore

**2018**

BTEC
Gold Award

**2018**

Platinum Partner
No.1 BTEC Centre
in Sri Lanka

**2017**

Asia's Training
Excellence Award

**2017**

Best Employer
Brand Award

**2017**

Platinum Partner
No.1 BTEC Centre
in Sri Lanka

**2016**

Educational Institute
with Best Academic
& Industry Interface

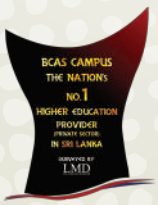
**2016**

Visionary Leadership
Award for
BCAS Chairman

**2016**

Academic
Impact Winner

**2016**




Ranked as No.1
Higher Education
Provider

**2014**

BTEC
Gold Partner

**2013**

Performance
Excellence Award

**2011**

Fastest Growing
BTEC Centre

**2010**

# EDITORIAL PREFACE

It is with great pleasure that we present the proceedings of the 8th International Conference on Multidisciplinary Research 2023 (iCMR). This marks the eighth consecutive organization of the conference in a series that commenced in 2015, maintaining its tradition of upholding academic excellence. Building upon the success of the previous six events, this conference has expanded its coverage across diverse specialty areas. This book encompasses the manuscripts of research work from numerous sub-specialties, all of which are anticipated to be presented in six parallel sessions on December 20, 2023, at the Odditorium, BCAS Campus, Colombo 03.

I extend my sincere appreciation to our chief guest, Ms. Kasthuri Chellaraja, and Keynote Speaker, Professor Rangika Halwathura, and especially our panelists, Prof. Ruvan Abeysekara, Dr. Lasantha Karunasekara and Mrs. Mrs. Ganga Wakishta Arachchi including moderator Dr. Chamara De Zoysa. Additionally, I express gratitude to all academics and participants for their invaluable contributions towards the development of a sustainable world. The editorial board is also deeply thankful to the authors for contributing high-quality research papers.

The manuscripts in this conference proceedings book underwent a double-blind review process by a panel of academics and professional experts with vast expertise in their respective fields. We acknowledge and appreciate the meticulous work carried out by these reviewers. Our gratitude extends to the members of the higher management of BCAS, the chairperson and members of the editorial board, and all others who volunteered their assistance to make this significant event a success. Furthermore, we recognize the financial sponsorship provided by organizations that have been instrumental in supporting the success of this annual BCAS symposium in 2023.

It is our earnest wish as editors that this conference proceedings book serves as a valuable resource for the research community and all other participants directly and indirectly involved in research work and studies.

**Dr. Mihira Wanninayake**
Editor-in-chief

## The Conference Chair

Dr. Susil Kumara Silva,
Executive Director/ CEO,
BCAS Campus

Dr Susil Kumara (PhD) , the Chief Executive officer, Executive Director, BCAS Campus and he also a Management consultant, Lecturer, Accredit Director, Management Consultant, Lecturer, and Accredited Director (SL), Member of Charted, CIPM, MSLIM, AMITD.

Dr Susil Kumara De Silva Holds a Master Degree in Human Resource management from University of Colombo, Masters of Business Administration from Buckinghamshire new University and PhD from University of Sri Jayawardenapura. He who is having more than 25 years' experience as a management professional in the sectors of Construction & Engineering, Trading, Apparel and Education, has hold positions such as CEO, Sr. Vice President, and Head of Group HR in large Corporations.

Dr Susil's areas of expertise include HRM, HRD, Business Administration, Marketing, Operation Management, People Development. He is the Gold Winner 2015 & 2016 and facilitated many such accolades. He also actively engages in research in the field of Management and is having many publications in locally and internationally recognized journals.

# Message from
# **The Conference Chair**

Dr. Susil Kumara Silva,
Executive Director/ CEO,
BCAS Campus

It is a pleasure for me to welcome the presenters and the participants to the 7th International Conference on Multi-disciplinary Research - 2023 in Colombo, Sri Lanka. The theme of this conference is “Navigating Through Turbulence: Role of Research and Innovation for Sustainable Future" which is extremely relevant in the context of today’s world for the vision of promoting innovative and sustainable research for tomorrow’s development. I as the chairperson of this year’s conference can say there have been six conferences on different themes successfully conducted by BCAS for in the past.

BCAS Campus organize this conference every year to get the talented, knowledgeable and dedicated people to meet and interact at one place. In that sense, we trust that this year’s conference will help generate great ideas from a variety of researches and exchange with one another the outcomes and expertise from professionals, colleagues and friends who are working round the clock for the world’s sustainable development.

This year’s conference focuses on seven different sectors in the role of research for a sustainable future. Such as (1) Biomedical and Health Sciences, (2) Information and Communication Technology (3) Legal Studies, (4) Finance and Business Management, (5) Engineering and Quantity Surveying, (6) Hospitality and Facility Management and (7) Humanities and social sciences. The abstracts of the researches are screened through a process of double-blind review and the extended papers are published in this Volume of Conference Proceedings.

The dedication and hard work of the organizing committee and the sub committees that contributed immensely towards making iCMR 2023 a reality is appreciable. Indeed, it is a significant landmark in our pursuit for excellence. I consider it as a great honour to be selected to the chair of the organizing committee. As for me, working closely with the colleagues from different schools and departments of BCAS is a unique and enriching experience.

I place on record my deepest appreciation on my personal behalf and on behalf of the organizing committee to all those (the editor-in-chief, the editorial committee and the panel of reviewers, et al.) who contributed tirelessly towards this endeavor for their unstinted and untiring efforts.

Further, as a chairperson I wish to express my sincere gratitude to our Chief Guest, Guest of Honour, keynote speakers, authors, members of the editorial committee, financial sponsors and many others who volunteered to assist to make this event a great success.

I sincerely hope that iCMR 2023 will be a rewarding experience for the presenters of research papers and the participants.

Best wishes and thank you,

**Dr. Susil Kumara Silva**
Chairperson, iCMR 2023

## Panel Member

Prof. Ruvan Abeysekara,
Vice Chancellor – BCAS Campus

Prof. Ruvan Abeysekara is an experienced IT professional who holds a PhD (Doctor of Engineering) in Computer Science and Technology from the University of Dalian, Peoples Republic of China (2013). He obtained a Master's degree from the University of Colombo-School of Computing, Sri Lanka, as a Master of Science in Computer Science in 2006. He also holds a Bachelor of Science degree from Sri Lanka in 1999, with comprehensive HR management, project management, lecturing, consultation, and management skills in both Face-to-Face (F2F) and Distance environments. In addition, he has a diploma in Financial Accountancy from Aquinas University College.

Prof. Abeysekara has expertise in IT policy and curriculum development, Distance/Multimedia learning content development, business information processing, enterprise application integration (EAI), systems integration, requirements analysis, workflow design, project management, leadership, process modeling, testing/quality assurance, software development, customer service, and vendor relationships. He also holds a National Diploma in Teaching Science from the National College of Education, Sri Lanka.

He has served as a Visiting Lecturer at the Institute of Personnel Management Sri Lanka. He was a former member of the Committee for Loan Scheme for Students to Follow Degrees at Non-State Higher Education Institutes Steering Committee and the Committee for Bachelor of Education Degree Steering Committee of the Ministry of Higher Education & Highways. He is a member of the Curriculum Development Committee of Joint Curriculum Development for Bachelor of Education Honours Degree Programme - National Institute of Education and SLANSHEI. He was a member representative for SLANSHEI a couple of times and executive committee member for once for the same. He is also a member of the Curriculum Development Committee of 13 Years of Schooling - National Institute of Education. He was a former Consultant for IT Infrastructure of SANASA Development Bank PLC.

Prof. Abeysekara is a member of several professional organizations, including the Institute of Doctors Engineers and Scientists, the Institution of Engineering and Technology, the Institute of Electrical and Electronics Engineers, the British Computer Society (Professional Member), the Computer Society of Sri Lanka, and the Australian Computer Society. He is a Microsoft Certified Peer Coacher and a Cisco Certified Instructor.

Prof. Abeysekara has held various teaching and management positions in different institutions, including the Ministry of Education, the Department of Examinations, the National Institute of Education, the Ceyline Group, the CINEC Campus, the PACE Institute, Infortec International University College, KAATSU International University, the University of Sri Jayawardenepura, the University of Technology Sri Lanka, and the Institute of Chartered Accountants of Sri Lanka. He worked as the Dean of the School of Computing, Professor of Computer Science, and was promoted to Deputy Vice-Chancellor at ESOFT Metro Campus. He is was the Vice-Chancellor and Professor of Computer Science at IDM Campus.

Prof. Abeysekara is a proficient problem-solver who visualizes business and technical perspectives to develop workable solutions. He is a good communicator and a better go-getter who enjoys achieving targets in a timely manner both nationally and internationally.

# Message from
# **Panel Member**

Prof. Ruvan Abeysekara,
Vice Chancellor,
BCAS Campus

I extend a warm welcome to all of you participating in the 8th International Conference on Multidisciplinary Research (iCMR), hosted by BCAS Campus. As Vice Chancellor, it is my pleasure to witness the convergence of scholarly minds and innovative ideas under the theme "Emerging Technologies for Global Well-Being."

In this era of rapid technological advancements, the intersection of multidisciplinary research and emerging technologies holds the key to addressing global challenges and fostering well-being on a global scale. iCMR 2023 serves as a pivotal platform for researchers, scholars, and practitioners to explore and discuss the transformative potential of cutting edge technologies in promoting the welfare of our global community.

The proceedings of iCMR 2023 encapsulate a diverse array of research endeavors, each contributing to the overarching dialogue on how emerging technologies can be harnessed to enhance the well-being of individuals and societies worldwide. I commend the dedication and intellectual rigor demonstrated by each contributor, as your work collectively shapes the trajectory of multidisciplinary studies.

I express my sincere appreciation to the organizing committee, keynote speakers, and sponsors for their unwavering commitment to making this conference a hub for meaningful discourse and collaboration. Your efforts have laid the groundwork for an intellectually stimulating environment that encourages the exchange of ideas and the cultivation of collaborative networks.

As we embark on the exploration of "Emerging Technologies for Global Well-Being," I encourage all participants to actively engage in discussions, share insights, and forge connections that extend beyond the confines of this conference. May the interactions and collaborations initiated during iCMR 2023 contribute to the development of solutions that positively impact the well-being of our global community.

Wishing you a fruitful and inspiring experience at the 8th International Conference on Multidisciplinary Research.

**Prof. Ruvan Abeysekara**
Panellist, iCMR 2023

# The Chief Guest

Ms. Kasturi Chellaraja Wilson,
Executive Director Group CEO Hemas Holdings PLC.

Ms. Kasthuri Angela Chellaraja Wilson is the group chief executive officer and executive director of Hemas Holdings PLC. She is the first female Group CEO of a public quoted conglomerate in Sri Lanka.

She is a fellow of the Chartered Institute of Management Accountants Alumni of the Executive Leadership Programme Harvard Business School

Ms. Kasthuri started her career at Someswaran Jayewickreme & Co. (currently, Deloitte) in 1988 as an Audit Trainee. Then she held few appointments until she became a member of Hemas Holdings PLC in March 2002. She initially joined the organization as Director Finance at HemTours and continued to hold many senior management positions, including chief processing officer and managing director of the Hemas Transportation Sector. Her portfolio also included Hemas Aviation, Hemas Logistics and Hemas Maritime Services. In 2016, she was appointed as the managing director of Hemas Pharmaceuticals, Hemas Surgicals and Hemas Diagnostics.

She serves on the board of National Development Bank PLC as a non-executive director, along with several other Hemas subsidiaries in the healthcare, consumer and mobility sectors. Kasthuri also serves on the board of the Ceylon Chamber of Commerce. She was appointed as the Regional Champion for the World Bank for South Asia in April 2022 and UNICEF Sri Lanka Business Council (Child Rights and Business Principles) in April 2023.

She is also the immediate past president of the Sri Lanka Chamber of the Pharmaceutical Industry and was the first female to be elected as president of the Sri Lanka Chamber of the Pharmaceutical Industry (SLCPI). She has served as a non-executive director of Capital Alliance Holdings Limited till end of April 2023, was a council member of the National Sports Council of Sri Lanka till March 2022 and has served on boards of SLID ( Sri Lanka Institute of Directors ), CIMA Sri Lanka, Sri Lanka and the American Chamber of Commerce in Sri Lanka. and Lankan Angels Network (LAN) – a leading start up eco system in Sri Lanka.

# Message by
# **The Chief Guest**

Ms. Kasturi Chellaraja Wilson,
Executive Director Group CEO
Hemas Holdings PLC.

I take immense pleasure in extending my warm greetings and best wishes on the inauguration of the 8th International Conference on Multidisciplinary Research 2023.

It is truly an honour to be a part of the inaugural event and I extend my congratulations to all the participants and the BCAS international Conference on Multidisciplinary Research 2023 team. This conference holds the potential to be a catalyst for a global paradigm shift, fostering communication, analysis, and significant change in the world while nurturing future researchers.

The symposium features a significant number of research papers across diverse areas, providing an excellent platform for researchers, scholars, academics, and students, across various fields such as management, computing, legal studies, biomedical science, language studies, facility management and engineering, to showcase their cutting edge work and share best practices.

I would like to take this opportunity to thank the British College of Applied Studies for hosting the 8th iCMR, also known as the BCAS Annual Symposium. Your efforts in organizing this event are commendable.

I wish everyone involved the very best for a successful and enriching conference.

**Ms. Kasturi Chellaraja Wilson**
Executive Director Group CEO
Hemas Holdings PLC.

## The Keynote Speaker

Prof. Rangika Halwathura
Professor, Department of Civil Engineering,
University of Moratuwa

Prof. Rangika Halwaura is a professor in the Department of Civil Engineering, Faculty of Engineering, University of Moratuwa, Sri Lanka.

Prof. Halwathura graduated with first class honours from University of Moratuwa with a bachelor's of science in engineering. He later completed his doctorate degree in structural and building services engineering in 2008 from the same institution

As of 2017, Prof. Halwathura is recognized as the youngest professor of Civil Engineering in Sri Lanka. In 2016, he received the Committee of Vice-Chancellors and Directors's (CVCD)Most Outstanding Young Researcher award. He also won the Sri Lanka 2016 Energy Globe Award. He was nominated by the National Academy of Sciences and subsequently won the 2017 The World Academy of Sciences Young Scientist Award.

He has published over 70 research articles in peer reviewed international journals and has received several research grants from national and international institutions. Currently, he mainly focuses on sustainable design, Sustainable materials, and green technology.

# Message by
# **The Keynote Speaker**

Prof. Rangika Halwathura
Professor, Department of Civil Engineering, University of Moratuwa
Commissioner, Sri Lanka Inventors Commission

More the technology, more the complexity people relish every day. Further, the more we try new things, the more we threaten nature and the environment. The term sustainability has applied in the field and yet to do a post-mortem and reveal to check whether it has applied in the same way as it was defined. The world population increases beyond what it can bear and in addition, their needs are more sophisticated. Furthermore, modern science is trying to use all its powers to solve these sophistications within its ability, leading to many sophisticated solutions. Even within these sophisticated solutions, again the science will be used to find the best out of all. That's where the modern world has mistaken the whole good concept of sustainability, more than it was mistaken, it's more a misuse of the great concept for our own short term goals.

However, this whole practice is questionable and needs to adjust soon. Unless it will lead to irreversible damage to the present and to the future. the world should move; new things should be found. New knowledge should be surfaced. That makes the world progress. However, the origin of this matters to define its sustainability.

There are enough examples from history in every field that they were inspired by nature for the technology which they have used. From construction to agriculture to medicine to any field of study, the seed and the inspiration was mainly from nature and that made it more sustainable as well as matched the needs of the society while doing the minimum harm to nature.

The Nature Inspired Solutions (NIS) is Undoubtedly the future of science and inventions in the future. From history to today, there are many cutting edge technologies, which were real breakthroughs, and which were initiated from nature, however, for us to feel the real sense of nature, we need to escape from the technological trap which we are in today. Hence, it's high time for us to go back to the human mode from the auto mode, so within the complexity, the nature will mould you in such a way to stay away from the complexity, find the solutions either natural or near natural way and have a happy life with the minimum harm to the nature while keeping a better space for the future to plan their life as they wish.

**Prof. Rangika Halwathura**

Professor, Department of Civil Engineering,

University of Moratuwa

## Moderator

Dr. Chamara De Zoysa

Dr. Chamara De Zoysa is a well-known Senior Lecturer, Clinical Embryologist, Public Speaker, Business Consultant, Corporate Consultant and a Corporate Trainer. Dr. Chamara has completed his studies at St. Sylvester's College and Dharmaraja college- Kandy and offered a full scholarship from the Indian Government for his graduation from University of Delhi. He completed graduation specialized in Clinical Embryology from University of Delhi with a 1st division & I was the topper of Delhi University. After the graduation he worked as a Clinical Embryologist in Apollo Hospital – New Delhi and contributed to the Clinical Research in the areas of Infertility, IVF and the pregnancy complications. He holds a Diploma in Sports Medicine and Clinical Embryology from University of Delhi with Distinctions.

Dr. Chamara holds MBA (Master of Business Administration) Specialized in Marketing with a 1st Division in 2009 & he was the Batch Top of Faculty of Management Studies (FMS) – University of Delhi.Dr. Chamara has been awarded as "Student of the Year" of Delhi University in 2005 and 2008 based on his excellent Academic and the extra-curricular activity performances. He has awarded Dr. Abdul Kalam Gold Medal for the "Best Overall Performance" in 2009 being the most outstanding student of Delhi University. Dr.Chamara has completed LLM (Master in Law) in International Business, Specialized in Finance from University of Cardiff Metropolitan University (UK) in 2015 and he topped the batch.

He has worked as a Consultant for many organizations in different sectors such as Banking, FMCG, Pharmaceutical and Manufacturing. Further he has delivered guest lectures for many organizations including leading Government/State Universities in Sri Lanka and abroad Currently he is lecturing for the areas of Bio Medical Science, Business Management and Law in different local and international Universities and Institutes. He is contributing as a Consultant and a Trainer for many organizations. Dr. Chamara demonstrates a diversified knowledge, Teaching Experience, Research Experience & Industrial exposure in all functional verticals.

# Message by
# **Moderator**
## Dr. Chamara De Zoysa

It is indeed my great pleasure to be a part of international Conference on Multidisciplinary Research 2023.

Congratulations and wish you continued success and happiness to those who participate in the Research Conference and your accomplishments are even more impressive as you carried them out during a worldwide pandemic and major issues in Sri Lanka.

Believe in yourselves and it will make competent, empathetic, and trusting during the Research Conferences. It has been an honor to see you all grow personally and professionally in the area of Research which is indeed a global need.

With immense pride, I congratulate to all the participants and the Team of BCAS international Conference on Multidisciplinary Research 2023.

I believe that you will go out into the world with confidence in your abilities to communicate and analyze the world you encounter and with faith that you will affect great change in the world as a Great Future Researcher.

I am wishing the best for all during this pivotal time in your lives. Take time to celebrate as your hard work on Research and determination has led you to this point. It is the time for seize the future as you venture in a new normal as there are a number of opportunities available to you all. I look forward to seeing of your future successes and accomplishments. The Research has significant number of Research papers in diverse research areas and issues.

I am truly confident that the international Conference on Multidisciplinary Research 2023 will bear a fruitful result and lay the concrete foundation for the future development of diverse research areas beyond our walls in this virtual era.

Wish you all the very best and Good Luck.

**Dr. Chamara De Zoysa**
Moderator- international Conference on Multidisciplinary Research 2023

# Panel Member

## Dr. Lasantha Karunasekara

## Deputy CEO and Director of Medical Services at Lanka Hospitals PLC

Dr. Lasantha Karunasekara is the Deputy CEO and Director of Medical Services at Lanka Hospitals PLC since September 2021, with C suit-level positions for the last 10 Years.

With a unique dual role of overseeing overall medical operations and added duties of a Deputy CEO with hospital P&L responsibilities, Lasantha brings his passion for caring, curing and empathy through his medical background and translates these qualities to lead multi-facet teams in growing the business to the next level.

Entrusted as a key member with the task of transforming the organization to a performance-driven one, He was instrumental in developing the key strategic pillars for the organization with the executive committee for the organization in 2021. Currently, is providing leadership to many projects with respective heads in organizational restructuring, job gradings, competency framework, performance management, and succession planning in the transformation.

Lasantha's unique blend of knowledge on core medical, Business Administration, Management accounting, lean practices, and coaching experience has enabled him to lead many cross-functional teams on cost-optimizing projects in the hospital saving many millions by reducing waste as well as improving processes.

Before the current position, Lasantha held the responsibilities as the Director General Manager, Hemas Hospitals, Wattala for a tenure of 6 years from Sep 2015. Where he is credited with transforming the organization to a future-ready status by massively expanding service portfolios, infrastructure, and leadership development.

Lasantha is a medical graduate with a Doctor of Medicine from Moscow, Russia and holds an MBA (UK), CMA (Aus.), Lean Practitioner (ILM), and Certified Professional Coach (ICF). He is married with one son. He enjoys listening to music, singing karaoke, watching movies, and keeping fit. A teetotaler and a vegetarian for more than 15 years and is a keen advocate of leadership development within the organizations with a moto of “work passionately and enjoy whatever you do to bring the best out of you”

# Message by
# **Panel Member**

Dr. Lasantha Karunasekara
Deputy CEO and Director of Medical Services
at Lanka Hospitals PLC

Albert Einstein probably the most famous scientist of all time and receiver of the Nobel Prize for physics in 1921 once said “If we knew what we were doing, it would not be called research, would it?” a quote many decades ago but true to this day.

With the ever-changing dynamics of the world, a keyword spoken all around in business circles, at world summits is “sustainability” by managing People, Planet, and Profits (triple bottom line). This will need out-of-box thinking and Innovations to generate, examine, confirm, and apply new ideas to the real world where Research and Development will play a key role in saving our precious world for the next centuries to come.

Let me congratulate and wish all the best for the 8th International Conference on Multidisciplinary Research 2023 and also thank the British College of Applied Studies for organizing and hosting BCAS Annual Symposium, the 8th iCMR.

Also, would extend my gratitude and well wishes to the BCAS Campus and the organizing committees for tirelessly pursuing such herculean tasks in establishing a nationally and internationally recognized conference of this magnitude for the 8th year in succession.

**Dr Lasantha Karunasekara**
Deputy CEO and Director of Medical Services
at Lanka Hospitals PLC

## Panel Member

Mrs. Ganga Wakishta Arachchi
Deputy Solicitor General, at the Attorney General's Department, Sri Lanka.

Mrs. Ganga Wakishta Arachchi Attorney-at-Law from Sri Lanka Law College, (with a First Class) and completed a diploma in Forensic Medicine and Toxicology from the same University. She also completed a postgraduate diploma at Bandaranaike Centre for International Studies. She completed a master's degree in international Trade Law in 2009/2011. She also has a master's degree in international Maritime Law in 2016/2017 from International Maritime Law Institute, Malta

Mrs Wakishta Arachchi started her career as a Non Summary Counsel at Attorney General's Department and later joined the same as a State Counsel. She also served as the Chief Registrar of Judicial Departmnet of Fiji 2010-2012 (first expatriate to hold the said post) and a Senior State Counsel, Attorney General's Department, Sri Lanka. Currently she is the Deputy Solicitor General, at the Attorney General's Department, Sri Lanka.

She is also a visiting lecturer in several education institutes including General Sir John Kothalawala Defence University.

Message by
**Panel Member**
Ganga Wakishta Arachchi
Deputy Solicitor General,
at the Attorney General's Department, Sri Lanka

In the field of law, which I am more conversant with, the research arm is very active and crucial since the legal practitioners deal with multidisciplinary issues on a daily basis. However, enacting legislation or practicing alone would not suffice, there has to be ways and means of monitoring the implementation and the sustainability of the same. Any emerging technology that we use for the global well-being has to be practically possible. It is also important to focus on maintaining a sustainable practice to prevent environmental issues such as "climate change" as a result of new technologies.

Congratulations to BCAS! Congratulations to the Chairperson and his team of organizers for a job well done for eight successive years, and sincere thanks to the academic staff and the contributors of Articles/Papers who had made this symposium possible which has attracted local and international recognition, and has become a very much awaited event of the year.

Mrs. Ganga Wakishta Arachchi
Deputy Solicitor General,
at the Attorney General's Department, Sri Lanka

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## 8th INTERNATIONAL CONFERENCE ON MULTIDISCIPLINARY RESEARCH 2023

Session 01

## Health Sciences

# ASSESSMENT OF KNOWLEDGE, ATTITUDES, AND PRACTICES REGARDING PERSONAL PROTECTIVE EQUIPMENT AND PROTECTIVE MEASURES RELATED TO COVID-19 AMONG THE GENERAL PUBLIC IN SRI LANKA

**M. H. Sally[1*], O. S. M. Perera[1], H. A. K. Ranasinghe[2], and A. I. Abeykoon[3]**

*[1]Management & Science University, Malaysia*
*[2]Faculty of Science, University of Kelaniya, Sri Lanka*
*[3]Faculty of Medicine, General Sir John Kotelawala Defence University, Ratmalana, Sri Lanka*

## Abstract

COVID-19 has emerged as a global health crisis, affecting individuals worldwide. The primary approach to combat this issue revolves around the utilization of Personal Protective Equipment (PPE) and adherence to preventive measures. The objective of this research is to comprehensively assess and analyses the knowledge, attitudes, and practices of the general public in Sri Lanka concerning the use of PPE and preventive measures against COVID-19. A cross-sectional online survey was conducted from March 2021 to January 2022, involving 109 participants. The survey encompassed six socio-demographic factors, sixteen knowledge-related questions, eleven attitude-related questions, and seventeen practice-related questions. Data analysis was carried out utilizing descriptive statistics, normality tests, one-way ANOVA test, Mann-Whitney U test, Kruskal-Wallis test, and Pearson correlation test. The findings revealed that the participants possessed a moderate level of knowledge (55.0%), a moderate level of attitudes (54.1%) and an acceptable level of practices (67.0%). Within attitudes, 31.2% strongly disagreed to the purchase of PPE from roadside vendors indicating hesitance to purchase PPE from unhygienic and poorly maintained vendors. It was stressed by majority of the respondents (64.2%) for PPE to be cheaper in pharmacies. In practices, it was noted that majority (85.3%) of the respondents practice proper respiratory etiquette by sneezing or coughing into their elbows. Interestingly, 48.7% of the respondents tend to re-use the disposable face mask more than once. This study stands out as one of the limited research endeavors that have explored knowledge, attitudes, and practices (KAP) regarding the PPE usage and preventive measures within the general public of Sri Lanka. The results underscore the importance of involving health authorities and government bodies in conducting awareness programs specifically addressing COVID-19. Such initiatives are essential for enhancing the knowledge, attitudes, and practices of the Sri Lankan general public and reinforcing their responses to the ongoing pandemic.

## Extended Abstract

### 1. Introduction

COVID-19 pandemic has unleashed widespread devastation on a global scale, affecting millions of individuals worldwide. This infectious disease, caused by the Coronavirus SARS-CoV-2, primarily manifests as respiratory symptoms, ranging from mild common-cold like symptoms to severe complications such as chest pains, breathing difficulties, and even fatalities among the worst outcomes. The virus spreads through airborne droplets emitted by

infected individuals or by direct contact with contaminated surfaces. Notably, coronaviruses are enveloped, positive single-stranded RNA viruses capable of infecting both humans and various animal species (P. Velavan, 2020).

To combat the relentless spread of this virus, the general public has been strongly encouraged to adopt preventive measures and utilize Personal Protective Equipment (PPE). These measures include wearing face masks (such as the N-95 or surgical mask), gloves, face shields, eye protection, and hair covers. Adhering to these personal protective measures is of utmost importance to prevent the transmission of COVID-19. As advised by the World Health Organization (WHO), individuals should self-isolate and wear masks while experiencing symptoms, frequently wash hands with soap and water or use alcohol-based hand sanitizers, maintain a distance of at least 1 meter from individuals in public places, refrain from touching the face (especially the eyes, nose, and mouth), and seek medical advice when needed (WHO, 2021).

However, despite the critical role of PPE and preventive measures, studies on the knowledge, attitudes, and practices of the general public in Sri Lanka remains limited, since most of the studies are focusing on specific groups such as healthcare workers and medical students. Consequently, there exists a dearth of comprehensive data concerning the general public's understanding and implementation of PPE usage and preventive measures in Sri Lanka. Thus, this study aims to bridge this gap by providing an in-depth exploration of the knowledge, attitudes, and practices of the general public in Sri Lanka regarding PPE and preventive measures in the context of COVID-19.

## 2. Methodology

### A. Study Design

The study was an online descriptive cross-sectional study where a self-administered questionnaire was disseminated through Google Forms to the general public via e-mail or social media platforms. The questionnaire was prepared in all three languages (English, Sinhala, Tamil). The questionnaire contained multiple-choice questions, as well as yes/no based questions accounting to a total of 50 questions. The questionnaire was sectioned into part A (socio-demographic factors), part B (knowledge regarding PPE and protective measures), part C (attitudes regarding PPE and protective measures), and part D (practices regarding PPE and protective measures).

### B. Participant Selection

The study population consisted of the general public of Sri Lanka that were above the age of 18 and residents of Sri Lanka at the time of study. The Lwanga and Lemeshow equation was used to calculate the sample size (Lwanga & Lemeshow, 1991). The sample size was 384 and non-response rate was taken at 12%. The study was performed from March 2021 to January 2022. Ethical clearance was obtained from the Ethics Review Committee of the Faculty of Medicine, General Sir John Kotelawala Defence University (KDU). The participants were given the choice to participate or withdraw from the study at any required time during the study process. Informed consent was obtained prior to the questionnaire being answered by the participants.

### C. Data Analysis

The socio demographic characteristics, knowledge, attitudes, and practices were analyzed using descriptive statistics, normality tests, one-way ANOVA test, Mann-Whitney U test, Kruskal-Wallis test, and Pearson correlation test. A p value of less than or equal to 0.05 was considered as significant. The data analysis was done via the IBM SPSS Statistics software package version 25.

The participants in the study were presented with a comprehensive set of 16 knowledge-based questions, each carrying a maximum score of 1. To assess the participants' cumulative knowledge levels more effectively, a previously prepared marking scheme was employed. This scheme utilized a 5-point Likert-type scale, wherein a score of 1 represented "Very Low Knowledge" (ranging from 0 to 3), a score of 2 represented "Low Knowledge" (ranging from 4 to 7), a score of 3 represented "Moderate Knowledge" (ranging from 8 to 11), a score of 4 represented "High Knowledge" (ranging from 12 to 15), and a score of 5 represented "Very High Knowledge" (16) (Wasave, S, 2021).

A total of 11 attitude questions were given to the respondents and a maximum of 4 marks were awarded for each question with 4 marks for best attitude, 3 marks for good attitude, 2 marks for acceptable attitude, 1 mark for poor attitude, and 0 marks for the unacceptable attitude totaling the attitude score to 44 marks. The total marks were calculated to get a cumulative attitude score for each respondent. A previously prepared marking scheme was used for the 3-point Likert-type scale ranging from 1 to 3 with 1 representing "Poor attitude" (the scores ranged from 0-16), 2 representing "Moderate Attitude" (scores ranged from 17-32), and 3 representing "Good Attitude" (scores ranged from 33 to highest) (Wasave. S, 2021).

A set of 17 practice questions was used, with each correct answer being awarded a score of 1, resulting in a maximum possible score of 17. The total marks obtained by each respondent were then calculated to derive their practice score. These practice scores were subsequently categorized into a 5-point Likert-type scale, ranging from 1 to 5. According to the scale, a score of 1 represented "very poor practice" (ranging from 0 to 4), a score of 2 represented "poor practice" (ranging from 4.5 to 8), a score of 3 represented "acceptable practice" (ranging from 8.5 to 12), a score of 4 represented "good practice" (ranging from 12.5 to 16), and a score of 5 represented "very good practice" (ranging from 16.5 to 17) (Wasave. S, 2021).

## 3. Results and Discussion

### A. Socio-Demographic Profile

The total number of participants were 109 with the majority (57.8%, 63) being male, which coincides with other similar studies done in Asia (Wasave. S et al., 2021) (Ferdous. Z et al., 2020) (Islam. S et al., 2020) (Siddiquea. B, 2023). The majority of the respondents (51, 46.8%) in this study belonged to the age group 18-29 years. However, other similar studies done in Asia showed that majority of the respondents were aged from 30-49 years (Lee. M et al., 2021) (Wasave. S et al., 2021) (Zhong. B et al., 2020) (Qutob. N & Awartani. F, 2021). Most of the respondents (30.3%, 33) in this study have only completed their secondary level education, which aligns with other similar studies done in the Asian region specifically in South Korea and India (Lee. M et al., 2021) (Wasave. S et al., 2021). However, other similar studies done in China (Zhong. B et al., 2020), Saudi Arabia (Bazaid. S et al., 2020), and Palestine (Qutob. N & Awartani. F, 2021) within the Asian region showed that majority of the respondents attained a bachelor's degree or above. The occupational status in the study represented, that 46.8% of the respondents were employed, 6.4% were unemployed, 33% were students, 7.3% were self-employed, and 6.4% were retired.

### B. Knowledge Profile of Respondents

By calculating the total marks obtained by each respondent, a knowledge score was derived, which ranged from 6 to 16 for the population studied. The average knowledge score was determined to be 11.03. None of the respondents displayed very low knowledge (0%), 10 respondents (9.2%) demonstrated low knowledge, 60 respondents (55.0%) exhibited moderate knowledge, 28 respondents (25.7%) displayed high knowledge, and 11 respondents (10.1%) showcased very high knowledge. The majority of the respondents from this study were shown to possess a moderate knowledge which agrees with a study conducted worldwide with

those respondents presenting a moderate knowledge (62.7%) (Masoud. A et al., 2021). However, variations can be observed among the general public in other specific Asian regional studies. The respondents within China possessed a better knowledge (90%) (Zhong. B et al., 2020) when compared to the respondents residing in Sri Lanka, whereas two studies from Bangladesh showed that respondents possessed a lower knowledge of 35.9% (Islam. S et al., 2020) and 48.3% (Ferdous. Z et al., 2020) when compared to the respondents from Sri Lanka. In this study, the respondents highlighted the fact that the most crucial PPE to be used in prevention of the spread of Covid-19 is the face mask with 105 (96.3%) respondents stating this. The overall knowledge of respondents was shown to be good as there was no significant conflicting responses observed.

**C. Attitude Profile of Respondents**

The attitude score of the respondents ranged from 12 to 44 with a mean value of 32.21. The number of respondents with a poor attitude was observed to be 1 (0.9%), followed by a moderate attitude 59 (54.1%), and a good attitude 49 (45.0%). It was observed that 31.2% strongly disagreed to the purchase of PPE from roadside vendors indicating hesitance to purchase PPE from unhygienic and poorly maintained vendors. It was observed that 64.2% of the individuals strongly agreed to purchasing PPE for a cheaper price from pharmacies. Respondents were asked if the Sri Lankan government should enforce stricter rules on the general public during lockdowns with most (54.2%) strongly agreeing and agreeing to it, indicating the general public's request to improve the precautionary measures implemented to improve the safety of the civilians in the country.

**D. Practice Profile of Respondents**

It was observed that the majority of the respondents had acceptable practices 73 (67.0%), followed by good practices 22 (20.2%), poor practices 13 (11.9%), and very good practices 1 (0.9%) respectively. It was seen that majority (57.8%) of the respondents avoid going to crowded places. Studies in China, India, and Bangladesh showed that vast majority of the respondents from the studies tend to avoid crowded places with 96.4% (Zhong. B, 2020), 46.53% (Wasave. S, 2021), and 68.1% (Siddiquea. B, 2023) of the respondents respectively, practice this preventive measure. The majority (78.0%) of the respondents were seen to frequently wash their hands with soap and water or use a hand sanitizer when outdoors. It was observed that most (82.6%) of the respondents would either wear a mask, glove, or face shield when going outdoors. The majority of the respondents (54.1%) tend not to touch the face, nose, or mouth when outdoors. Two Bangladesh studies and an Indian study showed that majority of the respondents tend to avoid touching the face or eyes with 91.6% (Islam. S et al., 2020), 60.9% (Ferdous. Z et al., 2020), and 44.28% (Wasave. S et al., 2021) of the respondents respectively, practice this preventive measure. 43.1% of the respondents tend to disinfect surfaces that are frequently touched indoors. It was observed that majority (85.3%) of the respondents practice proper respiratory etiquette by sneezing or coughing into their elbows. In this study, 48.7% of the respondents tend to re-use the disposable face mask more than once, which is a better practice compared to studies done in India (55.8%) (Sayare. B et al., 2021) and Vietnam (73%) (Duong. M et al., 2021). However, other studies done in the Asian region showed that UAE (43%) (Ajaj. R et al., 2023) and another study from Sri Lanka (36%) (Majeed. S et al., 2022) showed to have better practices on the re-use of disposable face masks.

**E. Knowledge, Attitude, and Practice Scores associated with Socio-Demographic Profile**

The distribution of the data in relation to the knowledge score and socio-demographic factors (age, gender, education, and occupation) was assessed. The results revealed that the mean knowledge score among the student group (12.11) was significantly higher compared to the other groups (p=0.010) (Table. 1). Furthermore, the mean knowledge score (11.78) was

significantly higher in the 18-29 age group compared to other age groups (p=0.005) (Table. 1). The mean knowledge score among males (11.08) was slightly higher than the females. Those that possessed a degree were shown to have a higher mean knowledge score (11.41) when compared to other education levels (Table. 1). Studies in China, South Korea, and Palestine respectively were shown to have female respondents to possess a higher mean knowledge score compared to males, and respondents that possessed a bachelor's or higher were shown to possess a higher mean knowledge scores compared to other education levels (Zhong. B et al., 2020) (Lee. M et al., 2021) (Qutob. N & Awatani. F, 2021).

Analysis of the attitude score and socio-demographic factors revealed that the mean attitude score (35.21) was significantly higher in the age group of 40-49 years compared to the other age groups (p=0.021) (Table. 1). This finding suggests that age plays a significant role in influencing the attitude score, with individuals between the ages of 40 and 49 exhibiting a higher mean attitude score compared to other age groups. Similar studies done in Bangladesh have revealed similar findings on the attitude score with studies claiming a higher mean attitude score for the age group above 30 (Siddiquea. B et al., 2023) (Ferdous. Z et al., 2020) and another study revealing a higher mean attitude score for the age group of 18-40. (Islam. S et al., 2020)

The distribution of practice score data related to socio-demographic factors were compared. The mean practice score was found to be significantly higher in the female group (11.80) compared to the male group (10.01) (p=0.000) (Table. 1). Studies that were done in Saudi Arabia, Palestine, and Bangladesh showed females to have a positive mean practice scores towards preventive measures over males (Bazaid. S et al., 2020) (Qutob. N & Awatani. F, 2021) (Ferdous. Z et al., 2020).

**F. Correlation between the knowledge levels and the attitude levels of the respondents**

The knowledge score and the attitude score were shown to be normally distributed; the correlation test was performed using the parametric Pearson correlation test. There was a significant moderate positive correlation (r=0.485; p<0.001) (Table. 2) indicating that when the person's knowledge increases the attitude also improves towards the use of PPE and preventive measures.

**G. Correlation between the knowledge levels and the practice levels of the respondents**

The knowledge score and the practice score were shown to be not normally distributed; the correlation test was performed using the non-parametric Spearman correlation test. There was a very slight positive correlation (r=0.098; p=0.309) (Table. 3) indicating that when the person's knowledge increases the practice also improves towards the use of PPE and the preventive measures.

**Table 01.** Knowledge, Attitudes, and Practices scores of the respondents associated with the socio-demographic factors.

| | Knowledge | | | | Attitudes | | | | Practices | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Parameter** | **Mean** | **SD** | **F value** | **P value** | **Mean** | **SD** | **F value** | **P value** | **Mean** | **SD** | **P value** |
| **Gender** | | | | | | | | | | | |
| Male | 11.08 | 2.9 | 0.055 | 0.816 | 31.98 | 5.4 | 0.236 | 0.628 | 10.01 | 1.9 | 0.000 |
| Female | 10.96 | 2.5 | | | 32.52 | 6.2 | | | 11.80 | 2.3 | |
| **Age** | | | | | | | | | | | |
| 18-29 | 11.78 | 2.7 | 4.484 | 0.005 | 31.49 | 6.5 | 3.393 | 0.021 | 10.57 | 2.4 | 0.664 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 30-39 | 10.04 | 2.6 | | | 33.65 | 3.7 | | | 10.92 | 2.4 | |
| 40-49 | 11.71 | 2.9 | | | 35.21 | 4.7 | | | 11.50 | 1.7 | |
| 50 or older | 9.78 | 1.8 | | | 29.83 | 5.0 | | | 10.53 | 2.0 | |
| **Education** | | | | | | | | | | | |
| Unschooled | 10.00 | 4.0 | 0.618 | 0.651 | 33.67 | 4.6 | 0.512 | 0.727 | 11.00 | 0.9 | 0.679 |
| O/L or A/L | 11.03 | 2.7 | | | 32.06 | 6.3 | | | 10.77 | 1.9 | |
| Diploma | 11.23 | 2.6 | | | 31.05 | 6.1 | | | 10.14 | 2.0 | |
| Bachelor's | 11.41 | 2.9 | | | 32.28 | 5.8 | | | 11.09 | 2.2 | |
| Degree | 10.32 | 2.2 | | | 33.47 | 4.0 | | | 10.90 | 3.2 | |
| Master or higher | | | | | | | | | | | |
| **Occupation** | | | | | | | | | | | |
| Unemployed | 9.86 | 2.9 | 3.496 | 0.010 | 31.00 | 5.8 | 1.645 | 0.168 | 10.14 | 1.9 | 0.817 |
| Student | 12.11 | 2.6 | | | 32.56 | 6.3 | | | 10.60 | 1.7 | |
| Employed | 10.90 | 2.6 | | | 33.08 | 4.8 | | | 10.99 | 2.5 | |
| Self-Employed | 9.63 | 2.2 | | | 28.88 | 7.3 | | | 10.69 | 3.3 | |
| Retired | 9.14 | 1.8 | | | 29.14 | 4.9 | | | 10.71 | 2.4 | |

**Table 2.** The correlation between the knowledge levels and the attitude levels of the respondents.

| Attitude Levels | Knowledge Levels | | | | | Total | Pearson correlation coefficient |
|---|---|---|---|---|---|---|---|
| | Very low knowledge | Low knowledge | Moderate knowledge | High knowledge | Very high knowledge | | |
| **Poor attitude** | 0 (0%) | 0 (0%) | 1 (100%) | 0 (0%) | 0 (0%) | 1 | 0.485 |
| **Moderate attitude** | 0 (0%) | 10 (16.9%) | 38 (64.5%) | 11 (18.6%) | 0 (0%) | 59 | |
| **Good attitude** | 0 (0%) | 0 (0%) | 21 (42.9%) | 17 (34.7%) | 11 (22.4%) | 49 | |

**Table 3.** The correlation between the knowledge levels and the practice levels of the respondents.

| Practice Levels | Knowledge Levels | | | | | Total | Spearman correlation coefficient |
|---|---|---|---|---|---|---|---|
| | Very low knowledge | Low knowledge | Moderate knowledge | High knowledge | Very high knowledge | | |
| **Very poor practices** | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | 0 | 0.098 |
| **poor practices** | 0 (0%) | 3 (23.1%) | 7 (53.8%) | 3 (23.1%) | 0 (0%) | 13 | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **acceptable practices** | 0 (0%) | 7 (9.6%) | 38 (52.1%) | 17 (23.3%) | 11 (15.1%) | 73 | |
| **good practices** | 0 (0%) | 0 (0%) | 15 (68.2%) | 7 (31.8%) | 0 (0%) | 22 | |
| **Very good practices** | 0 (0%) | 0 (0%) | 0 (0%) | 1 (100%) | 0 (0%) | 1 | |

## 4. Conclusion

This study provides a comprehensive analysis of the knowledge, attitudes, and practices of the general public towards PPE usage and preventive measures. The findings reveal that respondents generally possess a moderate level of knowledge (55.0%), maintain moderate attitudes (54.1%), and exhibit acceptable practices (67.0%). These results suggest that the Sri Lankan general public maintains an acceptable level of understanding and compliance with PPE and preventive measures against COVID-19. Given the limited sample size and the biases towards computer literacy of the study, the authors highly recommend that future studies be conducted with a larger sample to gain better and deeper insights and provide updated information.

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# PREVALENCE OF DIABETIC &VISUAL ACUITY AND THE ASSOCIATION BETWEEN DIABETES MELLITUS AND VISUAL ACUITY AMONG ATTENDEES FOR DRIVING LICENSES AT NTMI, BATTICALOA.

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## Abstract

The prevalence of Diabetes and problems with visual acuity have become more common in Sri Lanka during the previous couple of decades. This study aimed to determine the prevalence of Diabetic and visual acuity among attendees for driving licenses at the National Transport Medical Institute, Batticaloa. A cross-sectional study was carried out on 359 adults older than 17 years. Data was collected using a validated questionnaire. A glucometer was used to test blood glucose levels, and a Snellen chart was utilized to measure visual acuity. SPSS v 22 was used to conduct statistical analysis. Nearly 80.5% of the participants were male; their mean age was 39.2 (SD±12.82) years. The overall prevalence of diabetes was 22.6%, About 11.1% of overweight individuals have diabetes compared to those in the normal group. And the prevalence of both side's visual acuity was 30.36 %. The prevalence of right-sided visual impairment was 37.88%, while left-sided visual impairment was 35.09%. At the National Transport Medical Institute, the prevalence of diabetes was 1/5 and the prevalence of vision impairment was 1/3 among drivers. Furthermore, a significant connection between diabetes and impaired vision was observed while visual acuity has a link to age.

## Extended Abstract

- **Introduction**

Diabetes is a severe metabolic condition characterized by high blood glucose levels. The most prevalent non-communicable disease (Thayaparan et al., 2022). VI is a common symptom of diabetes. In addition, some medical problems are known to increase the risk of vehicle accidents. Traffic safety advocates say that diseases like epilepsy and diabetes mellitus can impair vision or lead to a lack of body control (Hansotia et, al 1991). The current study aimed to ascertain how diabetes affects visual acuity and the prevalence of diabetes and VA among drivers.

- **Methodology**

  - Study design: Descriptive cross-sectional study
  - Study setting: National Transport Medical Institute, Batticaloa
  - Study period: From January to August
  - Study population: All attendees who were undergoing medical examinations at the NTMI, Batticaloa.
  - Sample size: 359
  - Sampling technique: A systematic sampling technique
  - Study instrument: Auto code prodigy glucometer, Snellen chart, validated questionnaire
  - Data analysis: IBM Statistical Package for the Social Sciences (SPSS) for Windows version 22.0. Inc

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## Results and Discussion

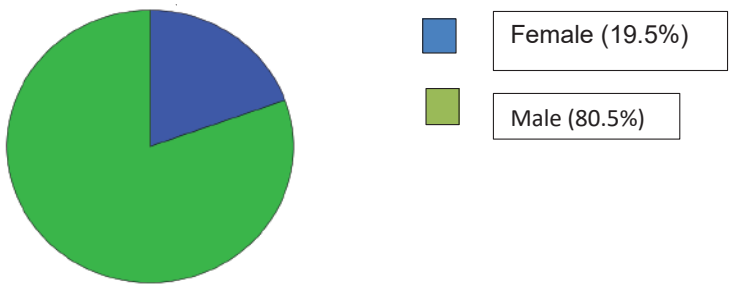


**Figure 1**:Category of gender in participants

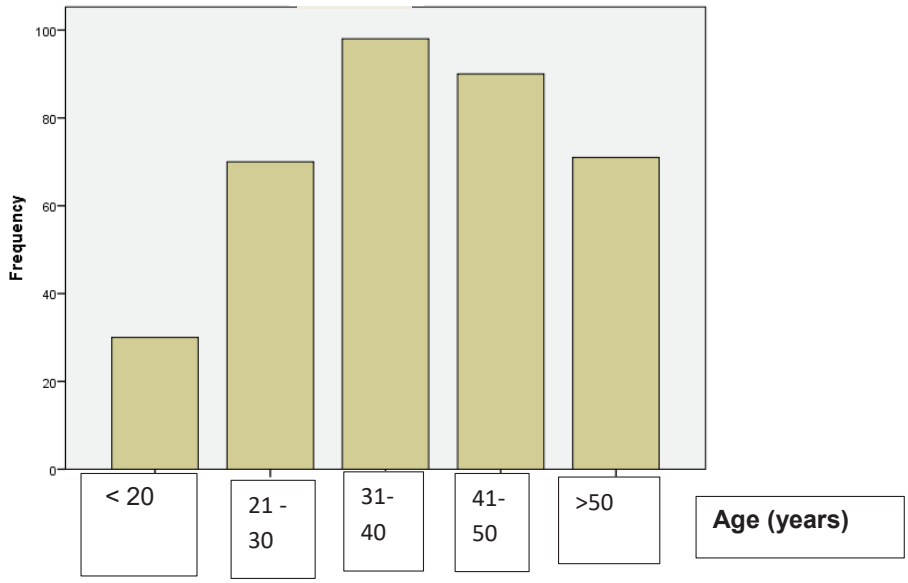


**Figure 2: Category of age group**

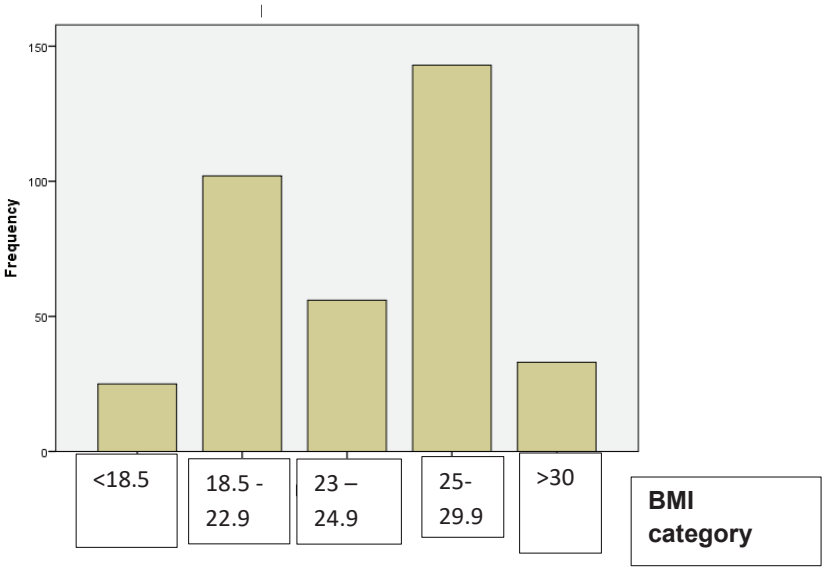


Figure 3: Category of participants' BMI

- The overall prevalence of diabetes is 22.6%.
- Right-side visual impairment prevalence was 37.88%, whereas the prevalence of vision impairment on the left side was 35.09%. Moreover, the prevalence of having both eyes are 30.36%.
- The percentage of those with hyperglycemia and mild to severe visual impairment in our study is 10.86%. Furthermore, Age and gender are associated with visual acuity.
- There is a statistically significant connection between diabetes and visual impairment in both eyes p-value was 0.029 ($p<0.05$). Diabetes and left-side visual impairment were significantly associated p-value was 0.011($p<0.05$). But Right-side visual impairment is not associated with diabetes p-value was 0.678($p > 0.05$).

- **Discussion**

This study found the prevalence rate of diabetes is 22.6% and the prevalence rate of visual acuity in both eyes is 30.36%. For those who have diabetes and vision impairments their prevalence is 10.86 %. Similar studies have been undertaken among the driving population across the world, however, this was a preliminary investigation in Sri Lanka. However, in 2022, the prevalence of diabetes among the general population in the Batticaloa district was 29%(Thayaparan *et al.*, 2022). In another study conducted in Sri Lanka by Katulanda *et al*., 2014, diabetes prevalence was 12.0% (n=536)(Katulanda, Ranasinghe, and Jayawardena, 2014). And 14.7% (De Silva *et al.*, 2018). This prevalence rate differs from our study owing to sample size and sample variables such as age, location, culture, and population.

The overall prevalence of right-side and left-side visual impairment was 37.88%, and 35.09% respectively. Moreover, the prevalence of having both eyes are 30.36%. According to research in Sri Lanka, the prevalence of vision impairment among the general population in the Gampaha district was 21.3%(Abeysena and Hapugoda, 2018). And 5.9% of Sri Lankans in the central province (Edussuriya *et al.*, 2009). Because of the sample size features, age, region, occupation and population, this prevalence rate differs from our study. Also, a visual impairment that had been assessed using the Snellen chart (Abeysena and Hapugoda, 2018) is similar to the current study but (Edussuriya *et al.*, 2009) study used slit-lamp examination and dilated stereoscopic fundus examination.

Furthermore, in our study, we found that about 34.84% of people over the age of 40 had some kind of vision disability. However, people of any age can have visual acuity. In addition to this Diabetes, Corneal opacity, and trauma were the causes of vision loss. Our research shows an association between diabetes and visual impairment in both eyes (p-value - 0.029 ($p<0.05$); This relationship inevitably leads to diabetic retinopathy.

- **Conclusions**

Diabetes prevalence was 1/5 among drivers and the prevalence of visual impairment was 1/3 among drivers at the National Transport Medical Institute, Batticaloa. Furthermore, a significant connection between diabetes and impaired vision was observed while visual acuity has a link to age. Furthermore, a venous blood sample or an HbA1c test can be used to ensure accuracy.

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# THE STUDY OF PREVENTION AND MANAGEMENT OF *OBESITY* AND ITS HEALTH-RELATED COMORBIDITIES IN ADOLESCENTS

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## Abstract

This systematic literature review of facts and design aims to fill in the gaps left by earlier and ongoing research on pharmacotherapy and surgical treatment for managing obesity in adolescents in Sri Lanka. Furthermore, this research explores the causes, risk factors, health comorbidities, complications, non-pharmacological and prevention and management of obesity in adolescents. Worldwide, the prevalence of obesity in adolescents is rising daily, leading to various health comorbidities. One of the main risk factors for the global rise in Type 2 Diabetes Mellitus is obesity in adolescents.

Five pharmacotherapy themes were identified by the nine literature findings: Orlistat, Phentermine, Metformin, Liraglutide, and Exenatide for managing obesity in adolescents. Orlistat is the only Food and Drug Administration (FDA) approved drug for the management of obesity in adolescents, even though Metformin is used in clinical settings in Sri Lanka. Orlistat reduced lipid absorption results in decreased Body Mass Index (BMI), which prevents the absorption of fat-soluble vitamins A, D, E, and K, hence the need to take multivitamins.

Bariatric Surgery (BS) was identified as a theme for surgical treatment, and "Laparoscopic Adjustable Banding (LAGB), Laparoscopic Sleeve Gastrectomy (LSG) and Laparoscopic Roux-and-Y Gastric Bypass (LRYGB)" were identified as its three subthemes for management of obesity in adolescents. LSG is the common, safe, effective, and reliable BS for managing obesity in adolescents worldwide. According to research findings, Sri Lanka conducted only LSG for an obese adolescent girl with considerable beneficial outcomes.

Obesity in adolescents is a persistent condition requiring continuous multidisciplinary treatment, including medication, with surgical treatment playing a crucial role. However, there is a pressing need for research in this demographic due to clinical development delays affecting future generations. Insufficient data exists about this growing population, emphasising the importance of promoting and advocating for targeted research initiatives.

Key Words: Obesity, Adolescents, Bariatric Surgery, Pharmacotherapy, Orlistat, BMI

## Extended Abstract

### 1. Introduction

Obesity is defined as fat accumulation that is abnormal or excessive and could harm health. In the adolescent age group 12 to 19, obesity is more significant than two standard deviations above the World Health Organization growth reference median (World Health Organization, 2021).

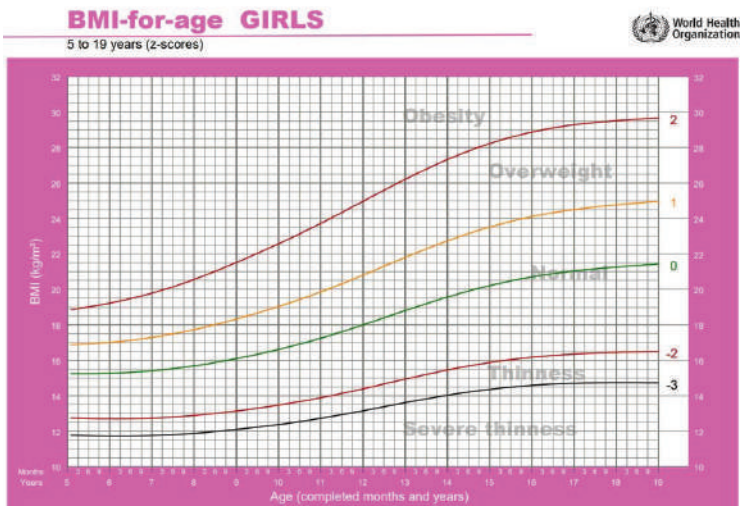


Fig 1: BMI for Girls Aged 5-19 Years

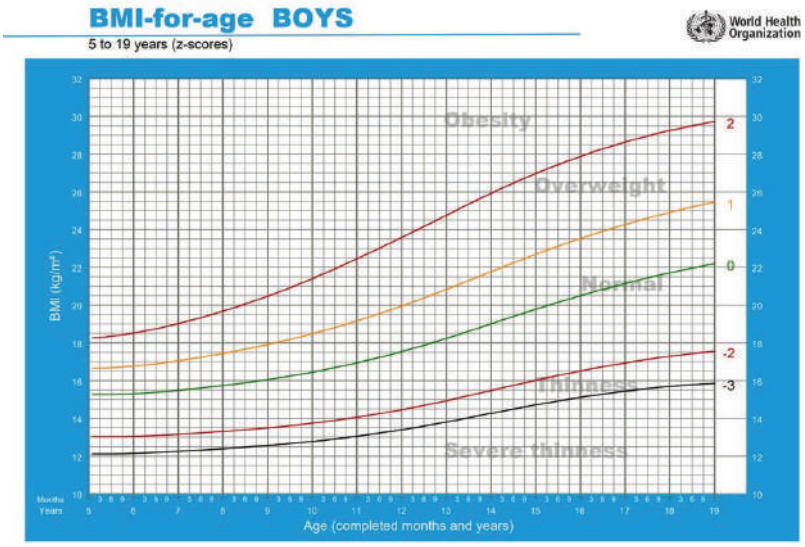


Fig 2: BMI for Boys Aged 5-19 Years

In Sri Lanka, obesity in adolescents is increasing rapidly. In 2016, obesity prevalence among Sri Lankan urban youth aged 5 to 18 was 10.3%, and overweight prevalence was 11.3%. A survey in 2019 shows that in the western province, the prevalence of obesity among 5-18-year-olds is 10.3%. Compared to Sri Lanka's non-national schools, adolescents attending national schools have been found to have higher rates of overnutrition. Research suggests that 75-80% of obese adolescents will remain obese throughout adulthood. In 2016, the global prevalence of obesity in adolescents was 7.8% in boys and 5.6% in girls (Gunawardana *et al.*, 2021).

At its most basic, excessive calorie consumption leads to increasing weight and excess fat mass, which is the core cause of obesity. Caloric imbalance is induced by various obesogenic factors, some of which might exacerbate it (Seneviratne *et al.*, 2021).

The main factors contributing to obesity are excessive consumption of sugary beverages, low-nutrient and high-saturated fat diets, insufficient physical exercise, high levels of sedentary behaviour, and inadequate sleep. The global food industry also promotes highly processed instant foods through aggressive marketing campaigns targeting adolescents (Seneviratne *et al.*, 2021). Obesity is influenced by genetics, interpersonal interactions, the environment, and community factors affecting dietary choices, physical activity levels, and screen time. Children and adolescents in Sri Lanka exhibit higher levels of total body fat mass and increased insulin resistance compared to other regions, potentially contributing to the country's high prevalence of metabolic issues associated with obesity.

Obesity significantly impacts non-communicable diseases such as diabetes, hypertension, dyslipidaemia, non-alcoholic fatty liver disease, asthma, anxiety, depression, and cancers. Compared to their non-overweight peers, obese adolescents also have decreased self-esteem, poor social functioning, and internalising behaviour. Obesity is also an economic health burden (Warnakulasuriya *et al.*, 2018).

In Sri Lanka, students and teachers lack knowledge about healthy food and a balanced diet, with a national curriculum that falls short in emphasising nutrition, posing a significant barrier to preventing obesity in adolescents. The focus on addressing childhood and adolescent obesity by national health associations is insufficient. Encouraging adolescents to adopt new lifestyle changes is the most challenging aspect of tackling this issue (Wickramasinghe, 2016; Seneviratne *et al.*, 2021).

## 2. Methodology

This systematic literature review is conducted using peer-reviewed findings journals. Themes were developed from nine literature to fill the research gap. The qualitative data collection

method is used. The thematic analysis method is used for analysing data. Journal articles published from 2015 to 2022 are mainly obtained for this research from Oxford Brookes University e-Library and scientific journals such as PMC and NHS. The research design is analysed using the theoretical concept of Saunders's Research Onion Model. The research methodology proceeds to the study design, which covers the key techniques and procedures for collecting and evaluating data. It begins with the "main philosophy, selects approaches, methods, and strategies, and sets time horizons." Interpretivism Philosophy, Deductive Approach, Qualitative Data, Grounded Theory research strategy and Cross-Sectional time horizon were used.

## 3. Results and Discussion

According to the selected nine literature, five themes were identified for pharmacotherapy, one theme for surgical treatment, and three sub-themes of bariatric surgery.

**Table 01.** Identified Themes

| Pharmacological Treatment | Surgical Treatment |
|---|---|
| Orlistat<br><br>Phentermine<br><br>Metformin<br><br>Liraglutide<br><br>Exenatide | Bariatric surgery<br><br>- LAGB<br><br>- LSG<br><br>- LRYGB |

Nine literature reviews helped to identify the management of obesity in adolescents using pharmacotherapy such as Orlistat, Phentermine, Metformin, Liraglutide, and Exenatide. Exenatide and Phentermine are Glucagon-Like Peptide 1 Receptor Agonist. Phentermine and Liraglutide suppress hunger, resulting in weight loss and reduction in BMI (Camacho et al., 2019; Woodard, Louque and Hsia, 2020; Singhal, Sella and Malhotra, 2021).

Orlistat prevents the absorption of fat-soluble vitamins A, D, E, and K, hence the need to take multivitamins. When considering side effects, Metformin, Liraglutide and Exenatide have gastrointestinal disturbances such as nausea, vomiting, and diarrhoea (Camacho *et al.*, 2019; Woodard, Louque and Hsia, 2020; Singhal, Sella and Malhotra, 2021). According to Table 03, Orlistat has a minimum half-life of the drug, and Phentermine has the highest half-life. In Sri Lanka, Orlistat is the only drug that the FDA approves for the management of obesity in adolescents.

**Table 02.** Summary of Nine Literature

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| | (Woodard, Louque and Hsia, 2020) | (Camacho *et al.*, 2019) | (Singhal, Sella and Malhotra, 2021) | (Nicolucci and Maffeis, 2022) | (Srivastava *et al.*, 2019) | (Cuda and Censani, 2022) | (Figlia-Peck, Feinstein and Fisher, 2020) | (Roebroek *et al.*, 2019) | (Soheilipour, Pishgahroudsari and Pazouki, 2022) |
| Themes | | | | | | | | | |
| pharmacotherapy | | | | | | | | | |
| Orlistat | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | |
| Phentermine | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | |
| Metformin | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | |
| Liraglutide | ✓ | ✓ | ✓ | ✓ | | ✓ | | | |
| Exenatide | ✓ | ✓ | ✓ | | ✓ | | | | |
| Surgical Intervention | | | | | | | | | |
| BS | ✓ | ✓ | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ |

The combination of Orlistat medication treatment with diet, exercise, and behavioural adjustment is well-tolerated, causes weight loss, and has a side effect profile similar to that reported in adults. It is recommended for long-term usage. Pharmacotherapy must be combined with diet, exercise, and behavioural modification for maximum therapeutic effect. When considering those facts, Orlistat can recommend the management of obesity in adolescents in Sri Lanka.

**Table 03.** Comparison of Drugs

| Drug | Mechanism of action | Side Effects | Contra-Indications | Half-Life of Drug | Elimination and Metabolism | Efficacy from Paediatric data |
|---|---|---|---|---|---|---|
| Orlistat<br>Gastric lipase inhibitor | Inhibits pancreatic and gastric lipase<br>Reduce lipid absorption | Oily stools<br>Stomach pain<br>Faecal urgency<br>Incontinence<br>Flatulence,<br>Flat soluble vitamin deficiency | Malabsorption<br>Cholestasis | Between 1-2 hours | Metabolised within the gut wall<br>95 to 97% of the unabsorbed and eliminated in the faeces. | 2.61 kg placebo-subtracted weight loss after one year of treatment (Singhal, Sella and Malhotra, 2021)<br>BMI reduced by 0.55 kg/m2 at 12 months (Nicolucci and Maffeis, 2022) |
| Phentermine<br>Norepinephrine reuptake inhibitor | Inhibits hypothalamic catecholamine release<br>Suppressing hunger and resulting in weight loss | Irritability<br>Sleeplessness,<br>Mood swings<br>Dry mouth<br>Dizziness<br>Tremor<br>Headaches | Glaucoma<br>Hyperthyroidism<br>Cardiovascular illness<br>Current usage of monoamine oxidase inhibitors are contraindications | Approximately 20 hours<br>When there is acid urine (pH <5), the elimination half-life is of 7-8 hours | Primarily eliminated in the urine<br>Approximately 70-80% of the prescribed dose can be detected as the unmodified substance | 4.1% reduction in BMI and a 3.2 kg reduction in weight at six months (Singhal, Sella and Malhotra, 2021; Nicolucci and Maffeis, 2022) |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | Increased heart rate and blood pressure | | | | |
| Metformin<br><br>Biguanide antihyperglycemic agent | suppressing glucose production in the liver and absorption from the intestine<br><br>Increasing glucose uptake in the periphery<br><br>Reduce weight and BMI | Gastrointestinal side effects include;<br><br>Bloating<br><br>Flatulence<br><br>Diarrhoea. | Severe Hepatic/Renal Disease | 6.2 hours in the plasma<br><br>Blood is approximately 17.6 hours | Excreted as an unchanged drug in the urine by the kidney and has no metabolites. | BMI Z score reduction of 0.1 and BMI reduction of 0.86 compared to placebo (Singhal, Sella and Malhotra, 2021) |
| Liraglutide<br><br>GLP-1 RA | Stops stomach emptying to induce fullness and suppresses hunger | Gastrointestinal side effects include;<br><br>Nausea<br><br>Vomiting<br><br>Diarrhoea | Pancreatitis<br><br>Cholelithiasis<br><br>Cholecystitis<br><br>Thyroid diseases | 13 hours | Filtered through the glomerulus<br><br>Metabolised more slowly portion of Liraglutide completely metabolised to carbon dioxide and water<br><br>6% excreted in urine and 5% excreted in faeces | BMI SDS reduction of 0.23 within 56 weeks<br><br>Reduction in BMI of at least 5% (Singhal, Sella and Malhotra, 2021)<br><br>Reduction in BMI of at least 5% (Nicolucci and Maffeis, 2022) |

| | | | | | | |
|---|---|---|---|---|---|---|
| Exenatide<br><br>GLP-1 RA | Enhance insulin secretion<br>Slowing gastric emptying<br><br>Act on the hypothalamus, limbic/ reward system, and cortex<br><br>Decrease BMI | Gastrointestinal side effects include;<br><br>Nausea<br><br>Vomiting<br><br>Diarrhoea<br><br>Hypoglycemia<br><br>Slight chance of cholelithiasis and pancreatitis | Personal or family history of medullary thyroid carcinoma or Type 2 multiple endocrine neoplasia | 2.4 hours | Eliminated through glomerular filtration<br><br>Proceeded by proteolysis, and lastly, excreted in the urine | BMI reduction of 3.42% with Exenatide for 3–6 months (Singhal, Sella and Malhotra, 2021) |

BS is the surgical treatment recommended for obesity in adolescents, and LAGB, LSG, and LRYGB are commonly used BS types. BS helps excess weight loss and decreases BMI, improving psychological outcomes and lessening the chance of developing potentially fatal weight-related health issues. BS may be less harmful to adolescents (5.5%) when compared with adults (9.8%). LSG and LRYGB are safe, effective, and trustworthy BS in adolescents (Schmoke, Ogle and Inge, 2000). However, LRYBG is slightly greater in weight loss and significantly enhances glycemic control (Schmoke, Ogle and Inge, 2000). In a comprehensive, multidisciplinary review by Schmoke, Ogle and Inge (2000), patients who received LRYGB and LSG experienced an average BMI decrease of 29% and 25% in three years after surgery, respectively. Furthermore, for a patient who has undergone LSG and needs further weight loss, LSG can be transformed into LRYGB in the case of postoperative Gastroesophageal Reflux Disease (GERD). Hence, the patient already has GERD; performing LRYGB in the baseline is better.

The benefits of LAGB over LRYGB and LSG include its simplicity, reversibility, avoidance of micronutrient deficiencies, and lack of changes to the gastrointestinal tract. LAGB was once popular among adolescents, but their decreased effectiveness compared to LSG and LRYGB caused them to lose popularity (Schmoke, Ogle and Inge, 2000).

LSG accounts for over 80% of adolescents and appears to have an improved safety and less complex profile compared to LRYGB and is now the most common adolescent BS performed in the US (Schmoke, Ogle and Inge, 2000).

The primary long-term side effect of BS in adolescents is malnutrition. Schmoke, Ogle and Inge (2000) found that iron deficiency occurred 45% after LSG and 75% after LRYGB. Parathyroid hormone levels were higher in adolescents undergoing LRYGB than in LSG. Due to possible malabsorption, vitamin B12 and D deficiency rates are higher in LRYGB than in LSG (Schmoke, Ogle and Inge, 2000).

When considering those factors, LSG is the common, safe, effective, and reliable BS for managing adolescent obesity. To the management of obesity in adolescents, BS is not well-established in Sri Lanka (Wickramasinghe, 2016).

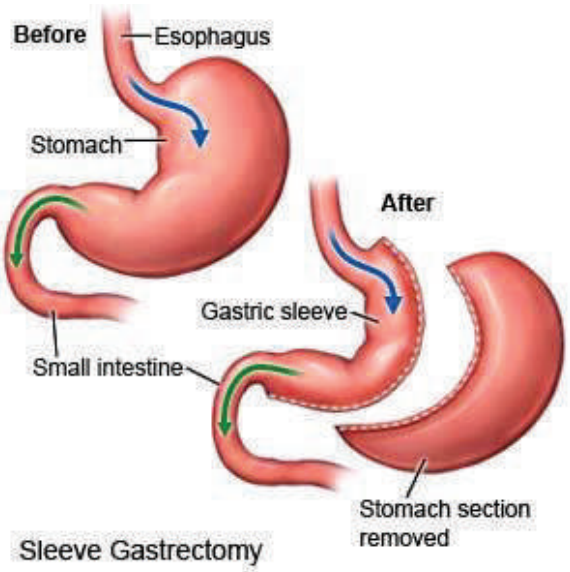


Fig. 3: Laparoscopic Sleeve Gastrectomy

There is a case study of a 13-year-old obese girl who lived with Continuous Positive Airway Pressure (CPAP). She had severe health comorbidities, such as OSA, DM, hyperactive disorder, depression, sibling rivalry, and suicidal attempts. She underwent LSG successfully at Colombo South Teaching Hospital Sri Lanka. Her BMI was 45, and she weighed 95 kg before surgery. Her weight decreased by 25kg after three months of surgery, and other complications were reduced, especially relief from CPAP (Kariyawasam *et al.*, 2021). Even though this study shows beneficial outcomes, BS is not considerably used in Sri Lanka for adolescents. Therefore, Sri Lanka needs more research and BS for adolescents who suffer severe health comorbidities of obesity.

## 4. Conclusion

According to selected nine literature, Orlistat, Phentermine, Metformin, Liraglutide, and Exenatide are recommended for PT. In Sri Lanka, Orlistat is the only drug the FDA approves for the management of obesity in adolescents. LAGB, LSG, and LRYGB are the recommended BS methods for managing obesity in adolescents. LSG is the common, safe, effective, and reliable BS for managing obesity in adolescents, and according to research findings, LSG is also recommended for Sri Lanka.

Finally, conclude that obese adolescents who do not have significant obesity-related health comorbidities may benefit from pharmacotherapy combined with lifestyle changes in Sri Lanka. With appropriate preoperative preparation and postoperative follow-up care, BS can be used as surgical treatment in adolescents with severe obesity and serious obesity-related health comorbidities in Sri Lanka.

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# ANALYSIS OF THE CHALLENGES OF BIOMEDICAL WASTE MANAGEMENT IN GOVERNMENT HOSPITALS IN SRI LANKA

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## Abstract

A hospital is the main place that produces biomedical waste in large quantities daily. The impact of biomedical waste has become a greater threat to the wellbeing of healthcare workers, the public, and the environment around the world than ever before. Annually, governments spend large amounts of taxpayers' money on biomedical waste management. However, it is generally acknowledged that the biomedical waste management practices in the context of Sri Lankan hospitals are not at a satisfactory level, particularly in Sri Lankan government hospitals. Therefore, the aim of the study is to determine the possible challenges of biomedical waste management in the Sri Lankan context. This is a descriptive study based on secondary data between 2004 and 2022 in peer-reviewed journals collected through a literature survey. Search engines include Google Scholar, PubMed, and Elsevier. Findings suggest six key challenges that need to be addressed to implement an effective biomedical waste management system in hospitals. This study is important because it is an integral part of a larger study on the challenges of biomedical waste management in the Sri Lankan context, which will help in devising an effective waste management system at the national policy level.

**Keywords:** Biomedical waste, Challenges of waste management, Hospital, Sri Lanka, Health workers

## 1. Introduction

Sri Lanka is one of the few countries that has had free health services for several decades. Every district has a government-based hospital and a widespread rural hospital system that covers all the districts of Sri Lanka. A hospital is the main place where biomedical waste is produced in large quantities daily. Due to the continuous development and expansion of the healthcare sector, the hospital system has become burdened with unnecessary and harmful biomedical waste (BMW).

The waste disposed of in the diagnosis, treatment, or immunization of human beings' animals or in research is called biomedical waste. Biomedical waste includes corrosive material with blood and body fluids or body parts, supplementary items etc., that is discarded from hospitals. Biomedical waste is classified as solid and is disposed of according to an identified scientific method (Rao et al., 2018). It is assumed that the total biomedical waste (BMW) is between 75% and 90% of the general harmful waste. The health risk waste amounts to 10% to 25% of BMW (Gazette, 2016). Biomedical Waste Management involves the entire process of safe disposal of BMW including people who generate, collect, receive, store, transport, and treat any nonhazardous or medical waste.

Especially during the Corona epidemic, a massive amount of biomedical waste accumulated in hospitals. During this period, due to the population density increase in government-sector hospitals, this situation led to an increase in the number of people receiving treatments in the hospital. With this development, the increasing amount of waste generated in the hospital is a serious problem. Hospital workers who play a major role in biomedical waste generation and disposal have a higher possibility of having sharp injuries, skin diseases, blood diseases, respiratory diseases, and other complications in the process. The dangerous situation here is, BMW is not only affecting people involved in this but also infecting external parties, animal communities, and the environment that we live in.

Generally, governments spend a large amount of taxpayer money on biomedical waste management annually. It is also accepted that there are adequate policies and laws in line with the National Environmental Act (NEA) and Ministry of Health (MOH) available in Sri Lanka for handling medical waste, including COVID-19 infectious waste (Suraweera et al., 2020). The analysis of Gunawardhana (2018) reveals that errors in BMWM (Biomedical Waste Management) have led to challenges in implementing a BMWM system in government hospitals in Sri Lanka. Effective biomedical waste management practices are not at a satisfactory level, particularly in Sri Lankan government hospitals, with negative effects on the environment and society. Given the importance of BMWM in government hospitals, it is important to understand the prevailing challenges in implementing an effective BMWM system. Therefore, the main purpose of this study is to analyze the challenges of implementing effective biomedical waste management in government hospitals in Sri Lanka using secondary information.

## 2. Methodology

This is mainly literature review-based research. The studies that were used for this study were published in peer-reviewed journals between 2004 and 2022. Seven studies were selected, analyzed, and included in the review, and the challenges have been identified accordingly. Four of them contain primary data, two of them have secondary data, and one has a varied database.

The quality is assessed using an appraisal competency programme checklist. The data was standardized through extraction. It has also provided the basis for changing ideas for qualitative research. Abstracts of other authors published in the search through Google, PubMed, Elsevier, and Scholar related to the topic were analyzed. Excluding criteria includes relevance, background and recognition of the source.

## 3. Results and Discussion

This research addressed the inevitable question of the challenges of biomedical waste management in the context of hospitals in Sri Lanka. This may seem like a very straightforward proclamation, but even after a few decades of work on biomedical waste management, scholars and practitioners are still paying attention to the challenges of biomedical waste management.

This study attempts to identify challenges of BWM practices in Sri Lanka. Though there are studies in other countries it was very difficult to find studies that focus on Sri Lankan context. It is very clear that there is a huge shortage of research studies in the Sri Lankan context.

Therefore, we use some studies out of Sri Lanka but seem relevant to Sri Lankan context. There is a huge vacuum of empirical studies in the Sri Lankan context about biomedical waste management, particularly in the health sector. Therefore, specific studies are needed. Considering this research vacuum and its importance for policymakers as well as health practitioners, this study focused on analyzing the challenges of biomedical waste management in the Sri Lankan context. Key challenges that have been identified and summarised from literature review related to the BMWM are presented in Table 01.

**Table 01.** Challenges identified from literature review

| S.N. | Reference of journals | Findings |
|---|---|---|
| 1 | Tushar, S.R., Alam, M.F.B., Bari, A.M. and Karmaker, C.L., 2023.<br><br>Assessing the challenges to medical waste management during the COVID-19 pandemic: Implications for the environmental sustainability in the emerging economies. | • Lack of proper law enforcement<br><br>• Insufficient financial support from investors and the government |
| 2 | Gunawardana, K. D., 2018<br><br>'An analysis of medical waste management practices in the health care sector in Colombo'; *Management of Environmental Quality: An International Journal*, *Vol. 29 Issue: 5, pp.813-825* | • Developing positive attitudes and knowledge on changes in waste management technology. |
| 3 | Jayawardena, D.B.A.S., 2018<br><br>'Critical Analysis of Clinical Waste Management System in National Hospital of Sri Lanka'. *Eur Exp Biol Vol. 8 No. 1:8*. | • There is no proper standardized BMWM system in Colombo General Hospital, Sri Lanka. |
| 4 | Ojha, P.C., Satpathy, S.S., Ojha, A.K., Sukla, L.B. and Pradhan, D., 2022<br><br>'Overcoming challenges due to enhanced biomedical waste generation during COVID-19 pandemic'. *The Science of the total environment*, *832*, 155072. | • BMW collection followed by segregation |
| 5 | Krishnamoorthy, Y., Anuradha, R., Rajaa, S., Samuel, G. and Sinha, I., 2022<br><br>'Biomedical waste disposal practices among healthcare workers during COVID-19 pandemic in secondary and tertiary care facilities of Tamil Nadu'; *Indian journal of medical microbiology*, *40*(4), 496–500. | • BMW Management policies and their implementation<br>• Improper BMW disposal practices |
| 6 | Saha, A. and Bhattacharjya, H., 2019<br><br>Health-Care Waste Management in Public Sector of Tripura, North-East India: An Observational Study | • The knowledge of health care workers in Tripura is lacking. |
| 7 | Tony, G., Kumar, N., Dsouza, B., Kamath, R. and Kamath, S., 2018<br><br>'System analysis of biomedical waste management across health care clinics of Udupi Taluk *Datta Meghe Inst Med Sci Univ* 2018; 13:199-201. | • lack of trained workforce<br>• non-compliance to segregation of waste, and<br>• non-compliance to collection and storage of waste |

Identified challenges can be categorized as issues in policies and law enforcement, shortage of funds, knowledge and attitudinal issues of the people involved, issues in disposal practices, and a lack of proper waste storage facilities. These challenges can be seen as the main issues in the Sri Lankan context. Further, Gunawardhana (2018) explained that the current challenges in Sri Lanka are a lack of making correct decisions at the correct time, irregularities, a lack of awareness, and financial difficulties in BMWM. Due to the availability of such challenges in hospitals, employee efficiency may decrease. Although rules and regulations have ensured the safe disposal of BMW in Sri Lanka, there is an immediate need to take action to uplift the current system capacity and increase funding for the safe disposal of BMW. If the waste is not disposed of properly, it also causes pollution of land and water, as well as, through infected syringes and needles, the transmission of incurable diseases like AIDS and the COVID-19 pandemic. Therefore, it affects the entire health sector in the country. Further, it was observed that there is a lack of specific studies on WMP in the context of Sri Lankan government hospitals.

## 4. Conclusion

Biomedical waste disposal has become a major problem in the healthcare sector. Therefore, implementing an effective biomedical waste management system has become more critical than ever in Sri Lanka. Understanding possible challenges is the key to devising an effective strategy for implementing an effective biomedical waste management system (BMWM). As a result, this study focuses on determining the challenges of implementing an effective biomedical waste management system in government hospitals in Sri Lanka using secondary data. Initially, a descriptive study was conducted based on the secondary data collected through a literature survey by analyzing seven research articles in the Asia and Africa regions related to this topic. Identified challenges include issues in policies and law enforcement, shortage of funds, knowledge and attitudinal issues of the people involved, issues in disposal practices, and a lack of proper waste storage facilities. These issues are generally applicable to the Sri Lankan context as well and will be instrumental for future studies in the context of Sri Lanka.

By identifying these challenges, the government and health authorities can implement comprehensive strategies to efficiently manage biomedical wastes from their origin until their final disposal. Further identifying challenges and mitigating them, the government can encourage eco-friendly systems for the disposal of BMW to decrease environmental pollution and ensure the safety of staff, patients, and the public, so that people can live in a clean and safe environment. BMW Management is a team effort with committed government involvement, good BMW practices followed by both healthcare workers and institutions, continuous monitoring, and a strong legislature. Therefore, the government should pay attention, with the collaboration of provincial health care authorities, to taking solid measures for allocating appropriate resources and periodically monitoring BMW disposal practices by devising an effective waste management system at the national, provincial, and hospital levels.

Accordingly, this study has a significant implication for the health sector, particularly within Sri Lanka, where it is believed that the challenges of biomedical waste management are lower compared to developed countries. Although the study was conducted in national hospitals, the findings of this research can be applied to both private and public hospitals as well. Therefore, the finding can apply to other similar hospitals within and across regions, as well as in low- and

middle-income countries. This study helps to understand what challenges have an impact on biomedical waste management in the context of Sri Lanka. By focusing on the challenges of biomedical waste management, health professionals and policymakers can decide where their attention should be directed. This facilitates policymakers' understanding of the factors and making policy-level changes at the national and regional levels to the existing health sector. This knowledge is important to developing a healthy community that will eventually benefit the entire country.

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# TRANSLATION QUALITY ASSESSMENT OF THE TRANSLATION TECHNIQUES EMPLOYED IN TRANSLATING AGRICULTURAL CONTENT: A COMPARATIVE STUDY WITH SPECIAL REFERENCE TO SELECTED SCIENTIFIC DOCUMENTS IN THE DEPARTMENT OF AGRICULTURE, PERADENIYA

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## Abstract

Scientific translation is considered to be a specialized translation field capable of bridging the knowledge gap in the multilingual world. As these texts convey the truth, these are informative texts which carry series of valuable information. Thus, the main objective was to evaluate the quality of those translated terms in the agriculture related texts from English into Sinhalese. Thereby the researcher's specific objectives are to determine the difficulties in translating agricultural terms and examine the appropriate translation techniques to translate agricultural terms. The research was conducted using a case study design and qualitative techniques as the method of the study. Observation method was used to conduct extensive reading of the documents in order to gather data and thereby relevant terms were extracted, and procedures were identified. According to the findings, six translation techniques were identified in the text when converting agricultural content from English to Sinhala. As per the analysis, the translation has a high readability level and is accurate and acceptable according to Nababan's (Nababan,1999) quality assessment theory. The researcher gave an overall average score of 2.73. This information led to the conclusion that the translations are successful in terms of acceptability, accuracy and readability. Other than that, the most frequent difficulty encountered by translators was the lack of terminological knowledge and the subject knowledge. Further, the researcher suggested translations using the appropriate strategies for unacceptable translations. Therefore, it is suggested that a glossary should be created for the area of agriculture in both English and Sinhalese.

**Key Words :** *Agricultural Terms, Agricultural Translation, Translation Techniques, Translation Quality Assessment, Challenges*

## 1. Introduction

Human beings communicate with themselves through language, which is a system of traditional spoken, signed, or written symbols. Communication identifies an expression, a play, a creative expression, and an emotional release as the purpose of the language. Translation is a connection between language and communication. It is commonly defined as the act of converting data from a (SL) source language to the (TL) target language. Though the general explanation of translation could be presented in this manner, many translators and linguists have defined translation in different ways based on its function, subject area, and so on. As (Newmark,1988) pointed out, 'translation is neither a theory nor a science, but just a collection of knowledge'. On the other hand, translation may be defined as the replacement of source language to another language. According to (Catford,1965), 'translation is the replacement of textual material in one language (SL) by equivalent textual material in another language (TL)'. It means, translation is written communication in a target that has the same meaning as the source language. It only changes the language, not the meaning of the source text. Translation can be divided into oral and written. Interpreting studies come under the oral category while translation studies fall under the written. Further, the written field of study can be divided into two parts as literary translation and non- literary translation or technical translation. Thus, this study is based on non-literary translation or in other words non-aesthetic or technical translation.

The present study discusses the scientific translation genre that falls under specialized translation category. Newmark (Newmark,1988) states that scientific translation is one part of specialized translation and terminology, and it makes technical translation differ from other forms of translation. According to Ghazali (Ghazali,1995), 'scientific translation is mainly about translating terms in the fields of science and technology of all kinds, medicine, physics, chemistry, mathematics, computer sciences from one language into another.' Scientific translation is not like other translations, and it goes beyond rendering words from one language into another. In addition to that, scientific translators are not like other ordinary translators. Certain qualifications are required in order to produce a perfect translation of scientific materials while delivering accurate information, because scientific translation involves more than transferring ideas or information; it is about transferring technology and new inventions among other fields and countries.

Generally, agriculture is the art and science of cultivating the soil, growing crops, and raising livestock. An agricultural text means a book or other written or printed word, which includes agricultural terms and other relevant information. Agricultural translation means, translating agriculture related documents into a specialized language combining biology, chemicals, or life sciences. For this research, the researcher selected two documents related to the field of agriculture.

Due to the aforesaid complexities in the scientific texts, the quality of a translation should be assessed. This is where TQA (Translation Quality Assessment) plays the key role. Translation quality is the degree to which a translation satisfies specific set standards or requirements. Specific context-related factors can be used to determine that quality. A high - quality translation captures the sense of the original text while being suitably phrased, error- free, and internally consistent. As stated by Nababan (1999), there are three aspects on which a translator must focus in order to assess the quality of translation. In his journal 'Pengembangan Model Penilaian Kualitas Terjemahan, he has introduced an instrument to assess the quality of translation based on three factors as; accuracy, acceptability, and readability. According to him, accuracy reflects how accurate the content from source language is transferred in the target language. Under the accuracy, there are three subcategories as; accurate, less accurate, and not accurate. Acceptability is a measure of how natural the language is used in the translation. It also has three categories as; acceptable, less acceptable, and not acceptable. Readability means how clear the message is translated from the source language to target language.

## 2. Methodology

### 2.1. Introduction

The research methodology chapter outlines the research approach, method, sampling technique, and data collection methods to guide the researcher in solving the relevant research problem. It covers data collection, statistical analysis, participant observations, and more.

### 2.2. Research Design

This study investigates the quality of translation techniques employed in translating agricultural content using qualitative techniques as the research approach. As a case study, it employs a deductive approach and uses primary and secondary data from the

Department of Agriculture's Annual Performance Report and Mushroom production article. The researcher uses purposive sampling technique to select sample sentences.

### 2.2.1. Data collection method

As mentioned in the research design, to collect the data, the researcher extensively read the documents and then extracted the specific terms and sentences. For this study, both primary and secondary data were selected.

- Primary Data: "Annual Performance Report (2016)" and " Article on Mushroom Production"
- Secondary Data : Textbooks, Journal Articles, Research Articles, Glossaries

### 2.2.2. Data Analysis

In the process of data analysis, the researcher organized the collected data under the translation procedures introduced by Vinay and Darbelnet (1958). The researcher also suggested translation procedures for inappropriate renderings. After that, the researcher assessed the quality of the translated agricultural terms using the assessment is based on three aspects: accuracy, acceptability, and readability. When assessing the translation quality, as the first step, the researcher calculated the quality of the sentences according to the above aspects one by one. Then, as the last step, the researcher calculated the quality of the entire selected data.

Table 2.2.2.1. : Number of documents and Sentences

| Number of documents | Name of the document | Number of sentences |
|---|---|---|
| 01 | • Annual Performance Report - 2016 (Department of Agriculture, Peradeniya) | 30 |
| 02 | • Mushroom Production in Sri Lanka (Department of Agriculture, Peradeniya) | 30 |

## 3. Results and Discussion

### 3.1. Introduction

This section analyzes data from the research, focusing on translation theories and quality assessment. It categorizes data under seven strategies proposed by Vinay and Darbelnet and evaluates translation quality under three Translation Quality Assessment (TQA) aspects introduced by Nababan. The strategies and the quality are discussed using selected documents.

### 3.2. Results and Discussion

After analyzing the data, a descriptive table was created for the relevant documents that were considered, describing the frequency and percentage of the seven theory-based translation strategies.

| Type of strategy | Frequency | Percentage |
|---|---|---|
| 1.Transposition | 10 | 16.7% |
| 2.Modulation | 3 | 5% |
| 3.Adaptation | 15 | 15% |
| 4.Borrowing<br>i.Regular borrowings<br>ii.Loan blend | 23 | 38.3% |
| 5.Calque | 7 | 11.7% |
| 6.Literal Translation | 2 | 3.3% |

The research reveals that the Sinhala translator utilized various strategies, with borrowing being the most common method, representing 38.3% of all strategies, aiming to convey agricultural content in a clear and natural manner.

**Examples :**

| Stratergy | Source Text | Target Text |
|---|---|---|
| 01.Transposition | • Different herbicides were tested to evaluate the weed controlling ability and phytotoxicity on maize crop. | • බඩඉරිඟු බෝගයේ වල් පැළෑටි පාලන හැකියාව හා ශාකයේ විෂවීම (phytotoxicity) ඇගයීම සඳහා විවිධ වල්නාශක පරීක්ෂා කරන ලදි. |

| | | |
|---|---|---|
| 02. Modulation | • Low moisture level in media causes the damage of mushroom by blue mold fungi more seriously. | • මාධ්‍යය වියළි විට කොළ පැහැති දිලීර මඟින් වන හානි වැඩි වේ. |
| 03.Adaptation | • Management of **chilli leaf curl virus** only by chemical applications is not economical and sustainable. | • රසායනික ක්‍රම වලින් පමණක් **මිරිස් කොළ කොඩවීමේ වෛරසය** පාලනය කිරීම ලාභදායී මෙන් ම තිරසාර ක්‍රමයක්ද නොවේ. |
| 04.Borrowing | • Anthracnose<br>• The bag should be made out of thermal resistant **Polypropylene bag** with a diameter of 15-20 cm. | • ඇන්ත්‍රැක්නෝස්<br>• මේ සඳහා සෙ.මී.15-20. පළල තාප ප්‍රතිරෝධී **පොලිප්‍රොපලීන් මලු** භාවිත කළ යුතුය. |
| 05.Calque | • **Black mold** of onion bulbs is caused by the fungus Aspergillus Niger. | • ඵැණු බල්බ වල **කළු පුස්** ආසාදනයට හේතු වන්නේ Aspergillus niger දිලීරයයි. |
| 06.Literal Translation | • Field Crop Research and Development Institute | • ක්ෂේත්‍ර බෝග පර්යේෂණ හා සංවර්ධන ආයතනය |

Though it is completely obvious that the translator has used only six strategies out of all the seven strategies introduced by Vinay and Darbelnet.

**Quality Assessment**

Nababan(1999) has introduced three aspects to assess the translation quality. According to those aspects, in this research, 60 sentences were selected for those three aspects. Below is the score results of the quality assessment of the three aspects.

| Aspects | Total score | average score |
|---|---|---|
| Accuracy | 158 | 2.63 |
| Acceptability | 170 | 2.83 |
| Readability | 170 | 2.83 |

According to Nababan's translation quality assessment, three aspects are used to determine the quality of a translation product as: accuracy, acceptability, and readability. After discussing the scores on the three aspects and the factors that influence the scores given to the sentences, it is possible to calculate the translation quality of the selected documents. Below is the formula designed to ease the calculation.

$$\text{Translation Quality} = \frac{(\text{Average score of accuracy}*3) + (\text{Average score of acceptability}*2) + (\text{Average score of readability}*1)}{\text{The total sum of each aspect value}}$$

The translation is accurate and acceptable, with a high readability level and an average score of 2.7, indicating a natural and acceptable transfer of agricultural terms from the source text.

When considering the challenges in translating agricultural content, it can be divided into two categories as terminology, and subject knowledge. Lack of terminological knowledge was the frequent important linguistic challenge confronted by translators when translating agricultural content from English to Sinhala.

**Examples:**

| Source text | Target Text |
|---|---|
| • Choanephora Blight | • කොනිෆොරි බ්ලයිට් |
| • Anthracnose | • ඇන්ත්‍රැක්නෝස් |
| • Panama disease | • පැනමා රෝගය |

According to the above table, the translator has transliterated the above source text's terms into target language because the source language does not have a specific meaning for those terms.

In accordance with the above results, the translator has used 06 translation strategies introduced by Vinay and Darbelnet when translating selected documents from English to Sinhala. In addition to that, the quality of the translation is at a high accuracy, high acceptable level with a high readability level.

## 4. Conclusions

Based on the discussion in the previous section, there are some points which can be concluded on this research.

- The results show that the translators have used six translation strategies introduced by Vinay and Darbelnet. According to those results, the most frequent technique was 'borrowing', and the percentage is 38.3%.

- When considering the translation quality, the accuracy level of the translated document is 68.3%. In addition to that, 25% were less accurate level while 6.7% were not accurate level. The percentage means that, generally, the content of the source text can be comprehended by the readers.

- The acceptability level of the translated documents is dominantly high, with 83.3% of the sentences being at the acceptable level and the rest, 16.6%, is in the less acceptable level. This data means that the text is widely accepted. However there are some parts of the text which are found unnatural for the readers.

- The documents' readability level is as high as their acceptability level, with 86.6% of the text falling into the high readability category,13.3% falling into the medium readability category, and 0% falling into the low readability category. The text can be read quite easily, and the reader can understand the text by reading it once.

- The final score of the translation quality assessment on the selected agricultural document is 2.73 out of 3, with an average score of each aspect:

    1.Accuracy - 2.63
    2.Acceptability - 2.83
    3. Readability - 2.83

- The most common challenges faced by translators when translating agricultural documents are lack of terminological knowledge and subject knowledge.

**Recommendations and Suggestions:**

- It would be better to prepare a glossary or terminology book related to the field of agriculture.

- The institutions and universities related to Translation Studies in Sri Lanka should encourage their learners and scholars to produce more research, glossaries, and studies addressing the sector of agricultural translation

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# DETERMINING THE STREET FOOD SAFETY-RELATED PRACTICES OF A SELECTED GROUP OF UNDERGRADUATES, SRI LANKA

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## Abstract

**Background:** Foods that are prepared and sold for immediate consumption on the street or in other public settings are known as street food. Due to poor food hygiene and management practices, street food safety has grown to be a major food safety concern.

**Objective/s:** This study aimed to assess the practices of street food safety among a selected group of undergraduates in Colombo, Sri Lanka.

**Methods:** A cross-sectional study was conducted among 332 randomly selected undergraduate students at a private university in Sri Lanka. A self-administered questionnaire was used to gather the data. Data analysis was conducted using SPSS 26, and statistical significance ($p<0.05$) was assessed using the Chi-square test. For the total practice score calculation, a score of less than 21 was considered to indicate a low level of food safety practices, 21–27 denoted an average level, and more than 27 was considered good.

**Results:** The majority of the participants were females (66.3%), aged between 18 and 25 years (79.8%), and unmarried (90.4%). The results showed that a large proportion of undergraduates had average food safety practices (36.1%). Socio-demographic factors did not have a significant effect on the level of food safety practices of the consumers ($p > 0.05$). The majority of customers (73.8%) were used to always washing their hands before eating street food and sometimes inspecting the sensory qualities (expiration date, freshness, and cleanliness) while purchasing street food (35.5%). Nearly half of the consumers sometimes observed the personal hygiene of food vendors (51.5%), whether the vendor kept the raw food and cooked food separately (50.6%), and whether the vendors served foods with bare hands (51.8%).

**Conclusion/s**: As most of the undergraduates had an average practice level, there is a need for strategies and intervention programs, including food safety training and awareness campaigns, to educate young adults regarding food safety. Also, further studies with enhanced sample proportions are necessary to confirm these findings.

**Keywords:** Food safety, Hygiene, Practices, Street Foods, Undergraduates

## Extended Abstract

### 1. Introduction

Food safety is a growing issue that has a big impact on public health everywhere(Luo et al., 2019).Street food is defined as any food or drink that is sold in the open, such as on the streets or in other public places, and is already prepared for consumption(Choudhury et al., 2011).Street foods may transmit pathogenic microorganisms that inevitably cause outbreaks of foodborne illnesses (Letuka et al., 2021).

Knowledge, attitudes , and practices about street food safety are of great concern among college students. Many studies have reported that college students have inadequate knowledge and inappropriate attitudes and practices about street food consumption and food safety that put their health at risk from foodborne diseases (Luo et al., 2019).

However, studies about practices of customers towards street food safety are constrained. Therefore, this survey will study street food safety through a selected group of Sri Lankan university students' practices.

### 2. Methodology

**Study design**- A cross-sectional anonymous online survey study was conducted at a private university (Kaatsu International University/KIU) in Colombo, Sri Lanka, among 332 university students using a pre-tested, self-administered questionnaire for assessing street food consumer practices.

The questionnaire contained a total of 48 items, divided into four parts: (i) socio-demographic characteristics of the participants (09 questions), (ii) assessment of food safety knowledge (14 questions), (iii) assessment of food safety attitude (12 questions) and (iv) assessment of food safety practices (13 questions). An informed consent statement was included at the beginning of the survey.

**Statistical analysis**-Questionnaires were checked manually before entering into Microsoft Excel 2016 spreadsheet. Coding, entering cleaning and analysis of collected data were done in IBM Statistical Package for Social Sciences (SPSS) version 26.

For total practice score calculation, a score of less than 21 was considered to indicate a low level of food safety practice, 21–27 denoted a satisfactory level, and more than 27 was considered good.

The practice scores regarding street food safety were expressed as mean and standard deviation (SD). Chi square test was used to assess the association between demographic characteristics and practice score of street food safety. All statistics were analyzed through a two-sided test. Statistical significance was defined as $p < 0.05$.

Ethical approval was obtained from the ERC of KIU (KIU_ERC_21_57).

### 3. Results and Discussion

Among the total university students (n = 332), there were 220 (66.3%) female students and 112 (33.7%) male students. Consumer age ranged from 18 to 45 years, with 79.8% between 18 and 25 years of age.

Assessed socio-demographic characteristics were gender, age, ethnicity, marital status, study program, academic year, accommodation method,and emplyment status No significant association was found between total practice level and the above mentioned consumers' socio-demographic factors as p value is > 0.05.

Table 1 - Socio-demographic factors associated with the food safety practices scores

| Socio demographic factors | | Total practices score category | | | Total | p value |
|---|---|---|---|---|---|---|
| | | Poor | Average | Good | | |
| Gender | Male | 30(27.0) | 40(33.3) | 42(41.6) | 112(33.7) | |
| | Female | 81(73.0) | 80(66.7) | 59(58.4) | 220(66.3) | 0.081 |
| Age | 18-25 | 87(78.4) | 94(78.3) | 84(83.2) | 265(79.8) | |
| | 26-35 | 19(17.1) | 24(20.0) | 16(15.8) | 59(17.8) | |
| | 36-45 | 5(4.5) | 2(1.7) | 1(1.0) | 8(2.4) | 0.417 |
| Ethnicity | Sinhalese | 93(83.8) | 86(71.7) | 79(78.2) | 258(77.7) | |
| | Tamils | 9(8.1) | 14(11.7) | 7(6.9) | 30(9.0) | |
| | Muslims | 8(7.2) | 15(12.5) | 12(11.9) | 35(10.5) | |
| | Burghers | 0(0) | 1(0.8) | 2(2.0) | 3(0.9) | |
| | Moors | 1(0.9) | 4(3.3) | (0)0 | 5(1.5) | |
| | Others | 0(0) | 0(0) | 1(1.0) | 1(0.3) | 0. 200 |
| Marital status | Unmarried | 100(90.1) | 108(90.0) | 92(91.1) | 300(90.4) | 0.957 |
| | Married | 11(9.9) | 12(10.0) | 9(8.9) | 32(9.6) | |
| Study program | Biomedical Science | 72(64.9) | 70(58.3) | 59(58.4) | 201(60.5) | 0.302 |
| | Management | 21(19.0) | 29(24.2) | 18(17.8) | 68(20.5) | |
| | Acupuncture | 3(2.7) | 8(06.7) | 6(5.9) | 17(5.1) | |
| | Nursing | 6(5.4) | 4(3.3) | 2(2.0) | 12(3.6) | |
| | Psychology | 7(6.3) | 9(7.5) | 13(12.9) | 29(8.7) | |
| | Kaatsu | 2(1.8) | 0(0) | 3(3.0) | 5(1.5) | |
| Academic year | First year | 29(26.1) | 20(16.7) | 24(23.8) | 73(22.0) | 0.426 |
| | Second year | 13(11.7) | 14(11.7) | 15(14.9) | 42(12.7) | |
| | Third year | 32(28.8) | 44(36.7) | 25(24.8) | 101(30.4) | |
| | Fourth year | 37(33.3) | 42(35.0) | 37(35.6) | 116(34.9) | |
| Employment status | Full time | 20(18.0) | 13(10.8) | 7(6.9) | 40(12.0) | 0.298 |
| | Part time | 12(10.8) | 10(8.3) | 14(13.9) | 36(10.8) | |
| | Training/Internships | 17(15.3) | 22(18.3) | 21(20.8) | 60(18.1) | |
| | Contractbased | 1(0.9) | 3(2.5) | 1(1.0) | 5(1.5) | |
| | Unemployed | 61(55.0) | 72(60.0) | 58(57.4) | 191(57.5) | |
| Accommodation method | My home | 54(48.6) | 63(52.5) | 53(52.5) | 170(51.2) | 0.932 |
| | Hostel | 10(9.0) | 12(10.0) | 13(12.9) | 35(10.5) | |
| | Boarding house | 37(33.3) | 34(28.3) | 29(28.7) | 100(30.1) | |
| | Friend's house | 5(4.5) | 4(3.3) | 2(2.0) | 11(3.3) | |

According to the data 33.4% of consumers had a poor practice on street food safety. Out of 332 study population, majority of participants (120, 36.1%) had an average practice and 30.4% respondents had a good practice on street food.

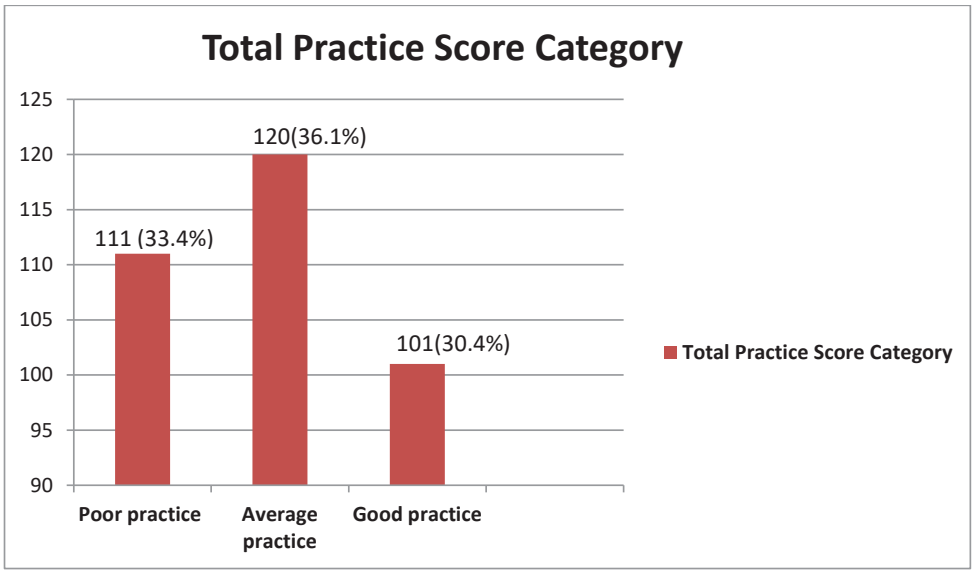


Figure 1 - Distribution of total food safety practice level among participants

## 4. Conclusions

In conclusion, the majority of the undergraduate students projected average practices toward street food safety.To raise young adults' awareness and hygiene level, continuous education is required. Additionally, training programs for university students need to be planned, monitored, and evaluated with greater care. Further studies are necessary to confirm these findings and give insight into the responses to street food safety by the student population.

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# ASSESSMENT OF PREVALENCE AND ANTIBIOTIC RESISTANCE PATTERNS OF UROPATHOGENIC COLIFORM ISOLATES: A RETROSPECTIVE STUDY AT A PRIVATE HOSPITAL IN GALLE, SRI LANKA.

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## Abstract

The management of urinary tract infections (UTIs) primarily relies on the use of antibiotics. However, the emergence and spread of antibiotic resistance among Coliform bacteria pose a significant challenge in the effective treatment of UTIs. Thus, this study was aimed to investigate the prevalence and antibiotic resistance rates of uropathogenic coliform species in culture-positive urine. A retrospective study was conducted at a private hospital in Galle, Sri Lanka between January 2023, and March 2023, including a total of 1453 urine culture samples. Data of uropathogenic coliform isolates with a colony count of $>10^5$ CFU/ml were analysed using IBM SPSS software version 26. The prevalence and the antibiotic resistance rates of Coliform species were expressed as frequencies and percentages. Out of 481 positive- culture samples, majority of the isolates were gram negative enteric organisms, commonly known as coliforms (401/83.4%), followed by *enterococci* (21, 4.4%), Coagulase negative *Staphylococcus* species(21,4.4%), and *Pseudomonas* species(14,2.9%) etc .Among these 401 patients, females were 286 (71.3%), and males were 115 (28.7%). The mean patient age was 41.21 + 1.22 years. The highest number of coliform cases in UTIs were observed among older adults (>45 years), comprising 170 (42.4%) of the total 401 coliform cases, followed by middle-aged adults (31-45 years) and young adults (17-30 years) accounted for 83 (20.7%) and 73 (18.2%), respectively.Among the coliforms isolated, extended - spectrum ß- lactamase (ESBL) production was confirmed in 111 isolates (23.1%). The highest bacterial resistance rates for antibiotics of coliform species not producing ESBL were as; Nalidixic acid (139/50.2%), ciprofloxacin (75/31.9%), Co-trimoxazole (69/23.9%),while ESBL producing coliform species showed the highest resistance to Nalidixic acid (86/79.6%), ciprofloxacin (72/76.6%), and Co-trimoxazole (65/58.6%). In conclusion, coliform species was the most common bacterial uropathogen isolated in this study. Females and older persons had a higher prevalence of coliform UTI cases. Coliforms showed the highest resistance to commonly used most of the first-line antibiotics.

**Keywords:** Antibiotics, Antimicrobial resistance, Coliform species, ESBL, Urinary tract infections.

## Extended Abstract

## 1. Introduction

A urinary tract infection (UTI) is a significant and serious public health issue characterized by inflammation resulting from the presence and multiplication of microorganisms in any part of the urinary system. It can affect either the lower urinary tract (urethritis, cystitis) and / or upper urinary tract (pyelonephritis) (Johnson et al., 2021).Because *E. coli* accounts for up to 80% of community-acquired uncomplicated UTIs, these bacteria should be targeted when choosing empirical antibiotics. An awareness of regional susceptibility data regarding *E. coli* (antibiograms) is very important for selecting appropriate empirical antibiotics. However, the rate at which *E. coli* strains are becoming resistant to the vast majority of antibiotics is increasing worldwide. In addition, *Enterobacteriaceae* harbor gene(s) conferring resistance to almost all antibiotics and plasmids harboring these resistance determinants can be transferred between bacteria, even between species, such that the acquisition of resistance to new antibiotics may only be a matter of time. Therefore, it is much more important to recognize practical rationales, including prescribing antibiotics when there is evidence of an infection, promoting appropriate use of antibiotics and increasing efforts for preventing UTIs. Following such strategies is essential because the abuse or misuse of antibiotics can lead to resistance via the emergence of mutant strains, and unresolved, relapsed UTIs tend to be resistant to previously used antibiotics (Lee et al, 2018).

## 2. Methodology

### Study design and study setting

A retrospective cross- sectional study was conducted at Clinical Microbiology Laboratory, Ruhunu Hospital (Pvt) Ltd., Galle, Sri Lanka from January 2023 to March 2023. A total of 1453 urine samples that were sent from both hospitalized and out-patient departments, were collected during the study period (January 2023 -March 2023). Midstream urine samples underwent microscopy and culture, with standard techniques used to identify the organisms. Antibiotic susceptibility testing (ABST) was performed using the Kirby-Bauer disk diffusion method as per the guidelines provided by the Clinical and Laboratory Standards Institute.

### Study criteria

#### *Inclusion criteria*

All patients diagnosed with UTIs based on positive urinary culture growth of a single pathogen with $>10^5$ colony-forming units per milliliter (CFU/mL) between January 2023 and March 2023 were included in the study. This included both hospitalized and out-patient cultures. In this study, the initial visit was considered the starting point for patients who experienced multiple UTI episodes.

#### *Exclusion criteria*

Patients with culture growth of $10^4 – 10^5$ CFU/ml, insignificant growth ($<10^4$ CFU/ml) , negative urine cultures, or mixed growth in urine cultures, and secondary episodes of UTIs of the individuals with numerous episodes of UTIs were excluded from the sample.

### Data Collection

Information related to UTI patients' socio-demographic characteristics, name of the uropathogen which isolated from urine culture and ABST results related to Coliforms were retrieved from the Laboratory Information System.

**Statistical analysis**

Data collected were entered into Microsoft excel 2010 and imported into IBM SPSS statistics version 26.0 for analysis. Descriptive statistics were applied to analyze the distribution of socio-demographic variables and antibiotic resistance rates, and the results were expressed as frequency and percentage.

## 3. Results and Discussion

Of a total of 1453 urine samples processed during the study period, 938 (64.6%) were collected from female patients and 515 (35.4%) from male patients. Among these total urine cultures, 621 samples (42.7%) showed no bacterial growth, 159 samples (10.9%) had insignificant bacterial growth, and 192 samples (13.2%) showed mixed bacterial growth. Only 481 (33.1%) of the total urine cultures yielded significant growth of organisms.

Table 1: Culture results of total urine culture samples

**Total urine culture samples**

| | Frequency | Percent |
|---|---|---|
| No bacterial growth | 621 | 42.7 |
| No significant growth | 159 | 10.9 |
| Mixed growth | 192 | 13.2 |
| Positive cultures | 481 | 33.1 |
| Total | 1453 | 100.0 |

| ISOLATED UROPATHOGENS (TOTAL = 481) | FREQUENCY | PERCENTAGE |
|---|---|---|
| GRAM NEGATIVE BACTERIA | | |
| ▪ Coliform species | 401 | 83.4% |
| ▪ *Pseudomonas* species | 14 | 2.9% |
| ▪ *Acinetobacter* species | 02 | 0.4% |
| GRAM POSITIVE BACTERIA | | |
| ▪ *Enterococcus* species | 21 | 4.4% |
| ▪ *Streptococcus s*pecies | 12 | 2.5% |
| ▪ *Staphylococcus saprophyticus* | 11 | 2.3% |
| ▪ Other Coagulase negative *staphylococcus* species | 10 | 2.1% |
| ▪ *Staphylococcus aureus* | 02 | 0.4% |
| BUDDING YEAST CELLS | | |
| ▪ *Candida* species | 08 | 1.7% |

Of the 481 culture-positive isolates, 417 (86.7%) strains of gram-negative bacteria, 56 (11.6%) strains of gram-positive bacteria, and 08 (1.7 %) strains of fungi were isolated. The most commonly found Gram-negative bacteria were Coliform sp., making up 83.4% of all isolates, while the most prevalent Gram-positive bacteria were *Enterococcus* sp., accounting for 4.4% of the total. Out of 401 positive cases with coliform species, 111 of them, which is equivalent to 23.1% of prevalence, were found to be coliform species that produce extended spectrum beta-lactamase (ESBL).

Table 2: Prevalence of uropathogens

Among all the coliform-yielded samples, the majority, 71.3% (n=286), were from female patients, while 28.7%(n=115) were from male patients. The mean age of study participants was 41.21, Individuals over the age of 45, known as older adults, had the highest number of coliform cases in UTIs, comprising 170 (42.4%) of the total 401 coliform cases. Middle-aged adults (31-45 years) and young adults (17-30 years) accounted for 83 (20.7%) and 73 (18.2%) of the total number of Coliform UTI cases, respectively.

Table 03; Age and gender distribution among coliform UTI cases

| **Age groups** | **Gender** | |
|---|---|---|
| | **Male (n, %)** | **Female (n, %)** |
| **0 – 2 years (Babies)** | 15 (13.0%) | 15 (5.3%) |
| **3 – 16 years (Children)** | 27 (23.5%) | 18 (6.3%) |
| **17- 30 years (Young Adults)** | 06 (5.2%) | 67 (23.4%) |
| **31 – 45 years (Middle-aged adults)** | 10 (8.7%) | 73 (25.8%) |
| **>45 years (Old adults)** | 57 (49.6%) | 113 (39.5%) |
| **Total** | 115 | 286 |

Antibiotic resistance rates of coliforms against commonly used antibiotics were indicated in the below mentioned table.

Table 4; Antibiotic resistance rates of coliforms

| **Antibiotic used** | **Antibiotic resistance rates** | |
|---|---|---|
| | **ESBL producing coliform species** | **coliform species not producing ESBL** |
| **Ciprofloxacin(CIP)** | **76.6% (n=72)** | **31.9%(n=75)** |
| **Cotrimazole(SXT)** | **58.6% (n=65)** | **23.9%(n=69)** |
| **Nalidixic acid(NA)** | **79.6%(n=86)** | **50.2%(n=139)** |

## 4. Conclusions

Our study concluded that Coliform species was found to be the most prevalent pathogen isolated from culture-positive UTI patients, followed by *Enterococcus* species. Antibiotic resistance of coliform species was observed among commonly using three first line antibiotics such as CIP, NA and SXT.

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# INVESTIGATION OF ALPHA AMYLASE ENZYME PRODUCTION OF *Bacillus* SPP. EXTRACTED FROM EXTREME ENVIRONMENTS AND THEIR BIOTECHNOLOGICAL APPLICATIONS.

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## Abstract

Alpha-amylase is an industrially important enzyme that catalyses the breakdown of starch into simple sugars. This study aims to investigate the production of alpha-amylase from *Bacillus* spp. isolated from Mahapelessa hot spring and Ussangoda coast in Sri Lanka. Amylase production was done using solid-state fermentation. Two kitchen wastes (Banana and potato peels) were tested as substrates. Previously isolated and sequenced *Bacillus* spp. from Mahapelessa hot spring (three *Bacillus subtilis* spp. Mmb4, mmb11, mmb14 ) and Ussangoda coast (two *Bacillus subtilis* spp.US14-3, US3-2, *Bacillus altitudinis* US6-1, *Bacillus stratosphericus* US12-2) were retrieved on Luria-Bertani (LB) media. The selected species were subjected to amylase screening to identify the amylase-producing bacteria. Then, amylase-positive species were fermented in LB broth with the waste substrate for the extraction of amylase. Next, the fermentation medium was shaken with 20mM phosphate buffer (pH=7) at 100 rpm for 30 minutes at 4 ˚C. After centrifuging the shaken medium at 7000 rpm for 20 minutes, the supernatant was collected as the crude alpha-amylase enzyme. The microplate-based starch-iodine assay was used to quantify the activity of amylase. The absorbance was taken at 580nm. All the selected *Bacillus* spp. were amylase-positive except *Bacillus subtilis* spp. mmb14. Amylase activity was reported high on potato peel substrate for cultures from both sites. The highest amylase activity was reported in *Bacillus subtilis* spp. mmb4 on the potato peel (2.75 U/mL) substrate while showing the highest activity (0.84U/mL) on the banana peel substrate as well. Among the Ussangoda coast cultures, the highest amylase activity(1.00 U/mL) was reported in US14-3 (*Bacillus subtilis*) on potato peel. According to the obtained results, the isolate mmb4 (*Bacillus subtilis*) is able to produce alpha-amylase at a relatively high temperature. Also, the obtained results confirmed that potato peel is a good waste substrate for the natural alpha-amylase production from bacteria.

**Keywords:** Alpha-Amylase, *Bacillus* spp., Solid-State Fermentation, Thermophilic, Waste

**Extended Abstract**

## 1. Introduction

Alpha-amylase is an enzyme that plays a vital role in numerous industries, including food, pharmaceuticals, detergent, textile, pulp and paper industries. Among different enzymes used in industries, alpha amylase is the most versatile enzyme due to the abundance of starch (1). Alpha-amylase catalyzes the hydrolysis of $\alpha$-1,4-linkages in starch molecules, resulting in simple sugars like glucose, maltose and maltodextrins. Alpha-amylases can be obtained from different living organisms such as plants, animals and microorganisms. Microorganisms are the most preferred organism for alpha-amylase production due to their easiness of handling, favourable growth conditions, availability and cheap nutrient requirements. Among different microorganisms, bacteria and fungi are mostly used to produce alpha amylases for industrial applications. According to the literature, the genus *Bacillus* has mainly been used to produce alpha amylases for commercial applications (2). *Bacillus* spp. has a substantial potential for use in different industries due to their favourable characteristics, including the ability to secrete enzymes and other proteins into the extracellular medium, short fermentation cycles, rapid growth rate, and safeness of handling.

Microorganisms that have the ability to grow and survive in extreme environments are known as extremophiles. These microorganisms are adapted at the molecular level to survive under such extreme conditions. Therefore, extremophiles can produce enzymes that can function under harsh conditions such as high temperatures, salinity, pH and pressure. Such enzymes are known as extremozymes. Extremozymes have attained a special interest in various industries due to their stability at high temperatures and wide range of pH, which are the predominant conditions in most industrial processes. Among different extremozymes, thermostable and halophilic alpha-amylases are one of the major industrial enzymes.

Both solid-state fermentation and submerged fermentation methods can be used to produce alpha-amylase using microorganisms. But solid-state fermentation is extensively used as it possesses numerous advantages such as low capital investment, lower energy requirement, simplicity, and better product recovery than the other methods. Different solid substrates can be used for the fermentation of alpha-amylase-producing microorganisms.

Synthetic alpha-amylase production is a costly process which requires expensive chemicals. But using food wastes, natural alpha-amylase can be produced at a lower cost under solid-state fermentation. The use of food waste as the substrate for industrially using alpha amylase also provides a solution to the global waste problem. This study used food wastes such as banana peels and potato peels as substrates, and the aim of the study is to investigate the low-cost production of industrially important alpha-amylase from extremophilic *Bacillus* spp. under solid-state fermentation using food waste.

## 2. Methodology

a. Culture retrieving.

The pure cultures of previously isolated and sequenced *Bacillus* spp. from Mahapelessa hot spring and Ussangoda coast, which were stored in the project culture collection, were retrieved on Luria-Bertani (LB) agar media. Two *Bacillus subtilis* species (US14-3 and US 3-2), *Bacillus altitudinis* (US6-1) and *Bacillus stratosphericus* (US12-2) were selected from the Ussangoda cultures while three *Bacillus subtilis* species (mmb4, mmb11 and mmb14) were selected from

the Mahapelssa hot spring cultures. After retrieving the cultures, Gram's staining was performed for all the selected *Bacillus* spp.

b. Amylase screening test.

An amylase screening test was performed on starch-agar media. A loop full of freshly grown bacterial cultures was inoculated on starch-agar media. Then, the inoculated media plates were incubated at 44.5 ˚C(Mahapelessa cultures) and 37℃ (Ussangoda coast cultures) for 24 hours. After 24 hours of incubation, the starch-agar media plates were flooded with the Iodine solution.

c. Fermentation.

All the amylase-positive species were fermented for the extraction of alpha-amylase enzyme. To prepare the inoculum, 20 µl of freshly grown bacterial culture was inoculated into 50 ml Luria-Bertani broth media in a 250 ml Erlenmeyer flask. The inoculum was incubated at 44.5 ˚C (Mahapelessa hot spring cultures) and 37 ˚C (Ussangoda coast cultures) for 48 hours. After incubation, 5g of the pre-treated substrate (Banana peels and potato peels) was separately added into the inoculation medium. Then, this fermentation media was incubated at 44.5 ˚C (Mahapelessa hot spring cultures) and 37 ˚C (Ussangoda coast cultures) for another 48 hours.

d. Extraction of crude alpha-amylase enzyme.

After the completion of the incubation period, the fermentation medium was soaked with 20 mM phosphate buffer (pH=7.0). Then, it was shaken at 100 rpm for 30 minutes at 4 ˚C on an orbital shaker (ORBITEK). Next, the medium was centrifuged (Centrifuge 5430R, Eppendorf) at 7000 rpm for 20 minutes at 4 ˚C. The supernatant was collected as the crude alpha-amylase enzyme, and it was stored at -20 ˚C until further use.

e. Quantification of alpha-amylase activity.

The enzyme activity of extracted crude alpha-amylase was quantified using the microplate-based starch-iodine quantitative assay. Under this assay, 40 µl of starch solution (2g/l), 40 µl of 0.1M phosphate buffer (pH=7.0) and 40 µl of the crude enzyme were added into wells of a 96-well plate. To minimize the evaporation, the microplate was covered with a plastic mat, and it was incubated at 44.5 ˚C (Mahapelessa hot spring cultures) and 37 ˚C (Ussangoda coast cultures) for 30 minutes. After the incubation, 20 µl of 1M HCl was added to each of the sample-containing wells to stop the reaction. Then, 100 µl of iodine reagent was added to each well. Next, 150 µl of the iodine-treated samples were transferred to a flat bottom 96-well plate, and the absorbance was taken at 580 nm using a microplate reader (FLUOstar Omega, BMG LABTECH). The alpha-amylase activity was calculated using the below equation. Under this assay, it was assumed that one unit of enzyme is equivalent to the average loss of 1 mg of iodine-binding starch material per minute.

$$\text{Alpha-amylase activity (U/ml)} = \frac{A_{580}\ \text{control} - A_{580}\ \text{sample}}{A_{580}/\text{mg starch} \times \text{assay time} \times \text{volume of the enzyme}}$$

## 3. Results and Discussion

According to the amylase screening test results, all the selected *Bacillus* spp. were amylase positive except the *Bacillus subtilis* spp. mmb14 isolated from Mahapelessa hot spring.

**Table 01**. Alpha amylase activity of selected *Bacillus* spp. isolated from Mahapelessa hot spring and Ussangoda coast.

| Sampling site | Substrate | Sample code | Species name | Enzyme activity (U/ml) |
|---|---|---|---|---|
| Ussangoda coast | Banana peel | US14-3 | *Bacillus subtilis* | 0.56 |
| | | US3-2 | *Bacillus subtilis* | 0.71 |
| | | US12-2 | *Bacillus stratosphericus* | 0.67 |
| | | US6-1 | *Bacillus atlitudinis* | 0.34 |
| | Potato peel | US14-3 | *Bacillus subtilis* | 1.00 |
| | | US3-2 | *Bacillus subtilis* | 0.36 |
| | | US12-2 | *Bacillus stratosphericus* | 0.69 |
| | | US6-1 | *Bacillus atlitudinis* | 0.30 |
| Mahapelessa hot spring | Banana peel | mmb4 | *Bacillus subtilis* | 0.84 |
| | | mmb11 | *Bacillus subtilis* | 0.63 |
| | Potato peel | mmb4 | *Bacillus subtilis* | 2.75 |
| | | mmb11 | *Bacillus subtilis* | 1.54 |

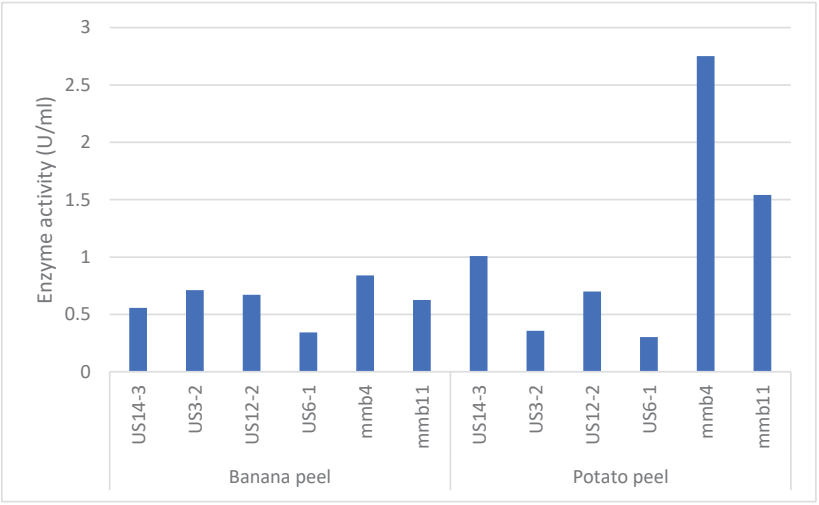


**Fig. 1:** Alpha-amylase activity of *Bacillus* spp. isolated from Ussangoda coast and Mahapelessa hot spring on banana peel substrate and potato peel substrate.

In this study, banana peels and potato peels were used as the substrates for the fermentation of bacteria. According to the results obtained from the Mahapelessa hot spring cultures, the alpha-amylase activity is higher on potato peel than on banana peel substrate (Figure 3). In Ussangoda coast cultures, the alpha-amylase activities of US14-3 (*Bacillus subtilis*) and US12-2 (*Bacillus stratosphericus*) samples were higher on potato peel than on banana peel substrate. But in US3-2 (*Bacillus subtilis*) and US6-1(*Bacillus altitudinis*) samples, the alpha-amylase activity is higher on banana peel than on potato peel substrate (Figure 2). The sample mmb4 (*Bacillus subtilis*) isolated from Mahapelessa hot spring shows the highest alpha-amylase activity on both potato peel (2.75 U/ml) and banana peel (0.84 U/ml) substrates (Figure 1). The Ussangoda coast sample US6-1 (*Bacillus altitudinis*) shows the lowest alpha-amylase activity on both potato peel (0.30U/ml) and banana peel (0.34 U/ml) substrates (Figure 1). Among all the selected *Bacillus* spp. and substrates, mmb4 *Bacillus subtilis* species isolated from Mahapelessa hot spring shows a significantly higher alpha-amylase activity on potato peel substrate.

**Fig. 2:** Alpha-amylase activity of *Bacillus* spp. isolated from Ussangoda coast on banana peel substrate and potato peel substrate.

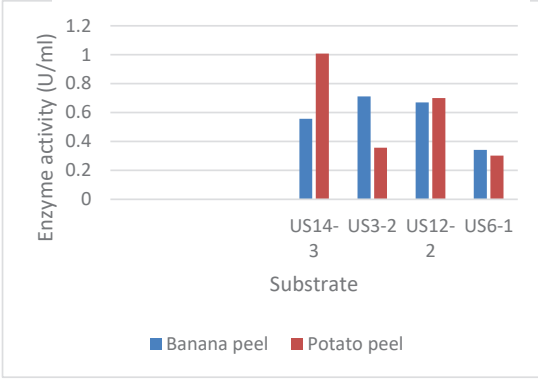
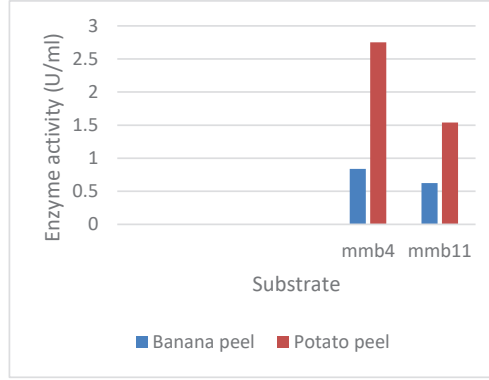



**Fig. 3:** Alpha-amylase activity of *Bacillus* spp. isolated from Mahapelessa hot spring on banana peel substrate and potato peel substrate.




## 4. Conclusions

According to the obtained results, Mahapelessa hot spring isolate mmb4 (*Bacillus subtilis*) shows a higher alpha-amylase activity at a relatively high temperature (44.5 ˚C) which is the optimum temperature of Mahapelessa hot spring. This study has also confirmed that potato peel is a good source of starch on which alpha-amylase-producing bacteria can act and therefore, can be used as the substrate for natural alpha-amylase production at a lower cost. The findings of this study show that industrially important alpha-amylases can be produced naturally with the use of natural habitats at a very low-cost using food waste. It also shows that the natural resources of Sri Lanka are of inestimable value.

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# EVALUATE THE MOST APPROPRIATE METHOD FOR THE PREVENTION OF NEONATAL HYPOTHERMIA

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## Abstract

Prevention of neonatal hypothermia is essential for a healthy future generation of a country as the lateral effects lead to organ damage and permanent medical issues. 17% of neonatal deaths were presented due to neonatal hypothermia occurring in 4 million neonatal deaths worldwide. The aim of this study is to compare and identify the best methods for preventing neonatal hypothermia among prevention methods practiced in health care set-up and community. The most appropriate 10 articles were scanned out of 803 related studies, published within the last 10 years and written in English. Despite all search engines, full body text was available in the database as human studies under clinical and randomized control trials were extracted. Search terms such as “Prevention Methods”, and “Neonatal Hypothermia” were used with AND Boolean operation in all fields in advance. The calculated temperature differences before and after applying the prevention methods are 1.6 ºC, 0.7 ºC, 0.5 ºC, 0.3 ºC, 0.2 ºC and 0.1 ºC respectively in the qualitative studies of non-electrical infant warmers, forced air warming devices, polyethylene bags combined with skin-to-skin care, conductive thermal mattress, a clear polyethylene plastic bag up to under the arms and Kangaroo Mother Care (KMC). From the selected literature specially focused on total body polyethene wrap and cloths/newspaper sandwich method, there is no evidence to calculate the temperature gap due to the intervention procedure led to the exemption of both studies. Practice, attitude & belief about neonatal hypothermia in the community and Knowledge about neonatal thermal care of physicians, nurses, midwives were evaluated through two qualitative studies. Due to the lack of knowledge and poor practice in the community, qualitative studies were not successful in order to prevent neonatal hypothermia. When comparing the above studies, it can be concluded that a forced air-warming device is the most suitable method for the prevention of hypothermia. By considering all possibilities and best outcomes with cost-effectiveness, the author can recommend the KMC as the best way to prevent neonatal hypothermia during the first day in the hospital or home not only to prevent the hypothermia but also to create the spiritual foundation of a neonate.

**Keywords**: Prevention methods, Neonate, Hypothermia, Neonatal hypothermia

**Extended Abstract**

## 1. Introduction

There is a major issue of a 99% neonatal mortality rate among poor countries and developing countries. When considering 4 million neonatal deaths worldwide, 40000 neonatal deaths occur in developed countries. The rest occurs in poor and developing countries. The median mortality rate of neonates in developing countries is 33 deaths per 1000 live births and in developed countries 4 neonatal deaths per 1000 live births. 75% of newborn babies die within the first week of their life. The greater common possibilities were neonatal sepsis (17.0%), hypothermia (17.0%) and breastfeeding problems (16.3%) in poor countries (Paul, 2006).

According to Delanaud *et al*., (2023) not only is the lower gestational age, but low-birth weight is also a common risk factor for neonatal hypothermia. As a result of immature neonatal organs and massive temperature losses, controlling neonatal body temperature is minimal than a matured child. When a newborn baby is exposed to a cold environment, the energy is used to keep the body temperature at normal body temperature in the range of 36.5-38$^0$C.

According to the Thermal Protection of the Newborn a Practical Guide, prevention of neonatal heat loss is important on term neonates and very useful on preterm and low birth weight babies. Wide body surface area, thin subcutaneous fat tissue and thin skin are the features that lead to hypothermia in low-birth-weight newborns. When the neonate is sick or has low birth weight or the mother is not available for skin-to-skin care it will need a longer stay in hospital. During this period thermal protection methods will be used according to the body weight, gestational age, and sickness of the baby. Hot water mattresses, overhead warmers, incubators, warm rooms and kangaroo mother care are the prevention methods of neonatal body temperature (World Health Organization, 1997).

## 2. Methodology

Studies coming up with data related to the risk factors and prevention of neonatal hypothermia in low-resource settings were determined. This review followed the Critical Appraisal Skills Program on the existing observational, experimental, clinical and randomized control trials. A wide PubMed search of published papers was carried out using search terms “Prevention Methods” and “Neonatal Hypothermia” with AND Boolean operation. The author of this study

scanned 803 articles and extracted 10 eligible articles. 74 articles were excluded due to not related to the study. 336 articles were kept away due to being old and 370 studies were systematic and literature review. 13 studies were rejected due to not providing prevention methods for neonatal heat loss and the inclusion criteria were human studies written in the English language and published within the last 10 years.

## 3. Results and Discussion

A qualitative study conducted by Kyokan *et al.*, (2022) explored the existing knowledge of health staff about newborn thermal protection in neonatal thermal guidelines and WHO guidelines through the use of two intervention cycles. 57 participants out of 100, understand the usefulness of the hand-touch methods in cold stress management and on thermal care guidelines whereas 43% of participants do not identify the essential for the prevention of newborn hypothermia by skin contact at the hand, foot and extremities before presenting it as neonatal hypothermia. Furthermore, the study shows that some of the staff members were confused regarding the definitions.

Furthermore, the study conducted by Lunze *et al.*, (2014) illustrates practices, attitudes & beliefs about neonatal hypothermia in community members and healthcare workers in resource-limited settings. According to this study, community members used to follow the few recommended steps of the WHO warm chain during the first hour of neonatal life. Skin-to-skin care was not applied due to, birth assistants paing attention to mothers following the delivery and most mothers had to engage in normal day-to-day activities such as household work and farming activities soon after delivery. The conclusion of this study was to apply skin-to-skin care, educate family members to help mothers and introduce cost-effective heating devices for preterm babies.

According to the comparison of the two studies mentioned above, there is inadequate knowledge among health workers and community members. Therefor introducing prevention methods for neonatal hypothermia into the school educational syllabus or higher education will be an added advantage to reducing the neonatal mortality rate.

Selected quantitative studies are basically based on the wrapping method, use of heating devices and Kangaroo mother care. The studies of a clear polyethylene plastic bag up to under the arms, total body polyethylene wrap, polyethylene bags combined with skin-to-skin care and cloths/newspaper sandwich method can be taken under the wrapping methods.

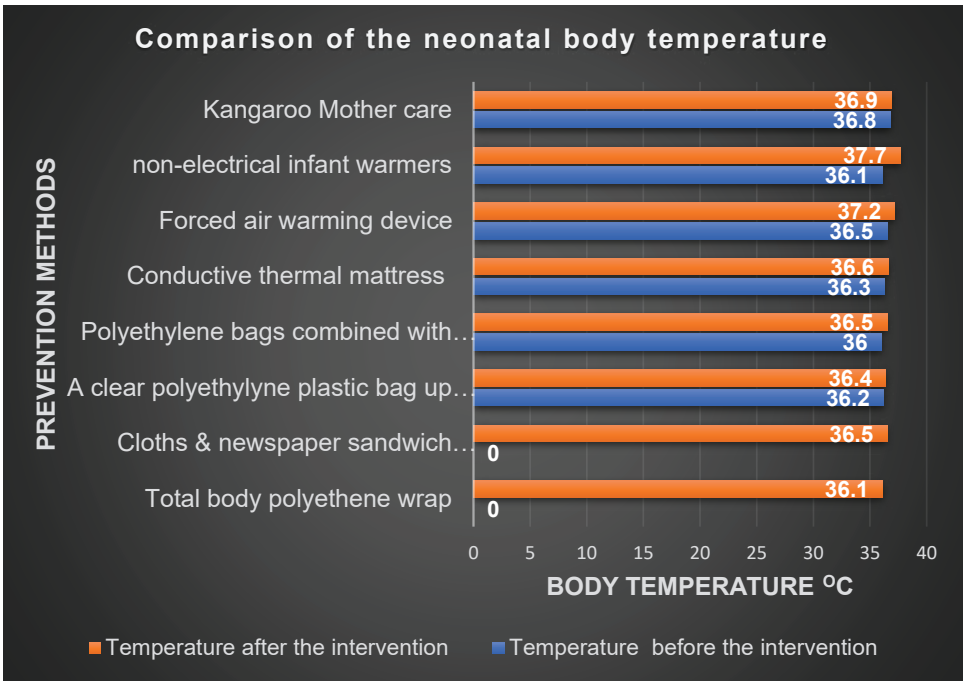


Figure 1. Neonatal body temperature values of intervention groups before and after applying the relevant prevention methods of quantitative studies

As shown in Figure 1, in all the prevention methods, there is a clear increase in neonatal body temperature after the intervention. Non-electrical infant warmers depicted the best performance by increasing temperature of 1.6 $^0$C even though, babies should undergo close observation as skin irritation, rash, burn and death were recorded whereas KMC gives the lowest difference in increase of temperature.

While one degree of temperature was reduced, the risk of mortality was elevated up to 80% in premature neonates than the term newborns who became moderate or severe hypothermia (Mullany *et al*., 2010). Therefore, all the above methods play a significant role in increasing the body temperature of neonates thus reducing mortality. After applying the prevention method to the intervention group subjected to the following methods of clear polyethylene plastic bag up to under the arms, conductive thermal mattress (37$^0$C) and KMC, it was observed that the increment of the temperature is less than 0.5$^0$C. Hyperthermia with continuous application and death were identified in the study of a clear polyethylene plastic bag up to under the arms. Hence, this method is useless. To present skin rashes, respiratory distress, sepsis, hypoglycemia and seizure at the end of the procedure, trying to obtain polyethylene bags combined with a skin-to-skin care method is dangerous for the neonates.

The conductive thermal mattress method which is useful in a short time duration to maintain body heat due to being harmless and it can be used for the prevention of hypothermia during transportation as it is not clinically meaningful due to the small sample size. KMC can be used for the prevention of hypothermia for a long-time duration due to not recorded hypothermia in neonates who got adequate KMC (Ramani *et al*., 2018). Further, KMC is a recommended element in the WHO thermoregulation guidelines for the practice.

## 4. Conclusions

Although the use of forced air-warming devices is the best way to prevent neonatal hypothermia in the hospital, it is quite expensive. KMC and Cloth/newspaper sandwich methods are effective in the Sri Lankan context as both interventions are cost-effective. Every mother or caregiver can easily find a newspaper at the lowest cost, and they can iron the papers and clothes at high temperatures to destroy the micro-organisms instead of the autoclave. Then they can be sandwiched by applying the newspapers in between two cloth layers which help to protect the body heat from convection, conduction, radiation and evaporation. KMC is the most cost-effective prevention method for preventing neonatal hypothermia with maternal love, safety and warmth. In this method, the mother's body heat automatically transfers to the newborn's baby and the mother acts as a heat source. It can be concluded that the best option would be KMC for the prevention of neonatal hypothermia.

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# A Study of Risk Factors and Prevention Strategies of Nosocomial Infection of UTI

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## Abstract

It is known that biomedical device-associated infections account for one-fourth of healthcare infections in the world. In particular, 10-50 % of urinary tract infections (UTI) were recorded from the patients who were subjected to short-term urinary catheterization. There has been a considerable effort to reduce the risk associated with UTI caused by urinary catheters as this type of hospital-acquired infection (HAI) or nosocomial infection accounted for 80% of the population from admission. reason for UTI. Therefore, catheter cleaning and replace is very important for prevent from CAUTI. UTI has different symptoms such as chills, fever, burning of the urethra, urinary leak in catheter, headache, cloudy urine due to pus, blood in the urine, achiness, foul-smelling in the urine, low back pain and headache etc. Other urine catheter related complications are bladder stones, blood in the urine, allergic, kidney damagers, infections in kidney, infections, in urinary tract, infection in blood and injury in urethra. UTI has different side effects such as bladder injuries, bladder stones, stomach cramp, urethra injuries, catheter leakages, pain in bladder, and bladder plasma etc. UTI has different risk factors but the main UTI risk factor is blockages in the catheter's drain system. Other risk factors are catheter disorganization, blockages in the catheter's drainage system not getting enough fibers and fluids etc. There are different antimicrobial urinary catheter coating agents are used to prevent urinary tract infection such as silver, antibiotics, chlorhexidine, triclosan, antimicrobial peptides, bacteriophages, enzyme, nitric oxide, polymeric coating modifications, liposomes, and polyzwitterions etc.

## Keywords

Urinary Tract Infection, Urinary Tract, Catheter

## Extended Abstract

### Introduction

If any person can't control when urinate, having urinary incontinence or having urinary retention they have to use a urinary catheter. There are many different reasons for not being able to urinate. Block urine flow due to bladder or kidney stones, blood clots in the urine and severe enlargement of the prostate gland may cause blocked urine flow. If someone had surgery on prostate gland, surgery in the genital area like hip fracture repair or hysterectomy can leads to that situation. Spinal cord injury, injury to the nerves of the bladder can happen when met an accident. Because of that can appear urinary problems. Catheters are available in a range of different materials. Some are impregnated with an antibiotic or coated with silver. Urinary catheters are the main reason for UTI. Therefore, catheter cleaning and replacement is very important for preventing CAUTI. Other risk factors are catheter disorganization, blockages in the catheter's drainage system not getting enough fibers and fluids etc. There are two types of urinary catheters used in hospitals such as one-time catheters and reusable catheters. Patients can prevent UTI from cleaning all parts in reusable catheters and didn't reuse one-time catheters. Patients can clean their body using soap before using the catheter. It is very important to minimize risk. Patients can use antimicrobial agents to prevent CAUTI. There are different types of antimicrobial agent use for preventing from CAUTI such as silver, antibiotics, chlorhexidine, triclosan, antimicrobial peptides, bacteriophages, enzyme, nitric oxide, polymeric coating modifications, liposomes, and polyzwitterions etc.

There are different antimicrobial agents used for CAUTI. Silver is one of the antimicrobial agents. Silver is a very good antimicrobial agent for Cather associated urinary tract infections. Therefore, silver is used for preventing hospital associated urinary catheter infections. There are different antibiotics used for CAUTI such as Nitrofular, Sparfloxacin, Rifampin, and minocycline. These antibiotics have low molecular weight compounds. Therefore, they can kill and inhibit the growth of other organisms. Bacteriophages are used for early prevention from hospital associated urinary tract infections. Because urinary catheters are the main reason for urinary tract infections. Bacteriophages are natural predators of bacteria. Bacteriophages can enter the bacteria inside, thereafter it can change and disrupt bacteria metabolic pathways. There are different types of enzymes are used for different functions, but antimicrobial enzymes are used for killing pathogenic microorganisms. Antimicrobial enzymes can attack pathogenic microorganisms.

Different enzymes affect different pathogens such as hydrolytic enzymes oxidative enzymes, and quorum quenching enzymes. Therefore, enzymes are very useful for preventing CAUTI.

## Methodology

A total of 918 records were obtained after searching through Google Scholar, PubMed, CINAHL, and BMC Journals. After screening the title and abstract, 898 articles were excluded due to their lack of relevance, and 20 articles were included in the study after a full-text assessment for eligibility.

## Results & Discussion

There are different pathogens involve making catheter associated urinary tract infection such as *E. coli, Candida spp, Enterococcus spp, P. aeruginosa, Klebsiella spp, Yeast NOS, Proteus spp, Enterobacter spp, CN staphylococci, S. aureus, and Bacteriodes app* etc. There are different antimicrobial urinary catheter coating agents are used to prevent urinary tract infection such as silver, antibiotics, chlorhexidine, triclosan, antimicrobial peptides, bacteriophages, enzyme, nitric oxide, polymeric coating modifications, liposomes, and polyzwitterions etc. These antimicrobial agents have different advantages and disadvantages. There are different antibiotics used for CAUTI such as Nitrofular, Sparfloxacin, Rifampin, and minocycline. These antibiotics have low molecular weight compounds. Therefore, they can kill and inhibit the growth of other organisms.Nitrofular can kill gram-positive bacteria, gram-negative bacteria, aerobic bacteria and anaerobic bacteria. This antibiotic is best for burns and for skin grafting. Sparfloxacin is involved to killing bacteria and it can prevent bacteria growth. But this antibiotic has some disadvantages such as this antibiotic is not working for virus infections. This antibiotic has different side effects such as headache, drowsiness, vomiting and nausea etc. Rifampin is another antibiotic used for CAUTI. This antibiotic is used for gram-negative bacteria, mycobacteria, and gram-positive bacteria. Its side effects are chest pains, fever, and patient's teeth, urine, saliva turns from reddish orange to reddish-brown color. Silver is a very good antimicrobial agent, but silver is toxic to fibroblasts when silver is in high concentration, and it can attack DNA, membranes, and proteins. But it has very good antimicrobial functions. Therefore, it is used for condoms. Chlorhexidine is a very good antimicrobial agent, but it has lot of side effects. It involves making stains in teeth and it can build up calculus. Triclosan has different advantages such as, triclosan is effective against

a broad spectrum of bacteria, including both gram-positive and gram-negative bacteria. Patients can use these antimicrobial agents and they can prevent UTI early. Triclosan has a long-lasting antimicrobial effect, and it has very good stability in various environments. Its disadvantages are it persists in the environment and has been detected in water bodies, soil, and even in human tissues. Liposome is very good antibiotic agent, but it has some disadvantages such as it has stability issues, and it has limited penetration into certain tissues or cells and its cost is little bit higher. Therefore, patients can use these different antimicrobial agents and they can prevent UTI early. Below table explains about pathogen risk percentage in CAUTI. *Escherichia coli* is the highest risky pathogen for CAUTI.

Table 01 – Pathogen risk percentage in CAUTI.

| Pathogens. | Pathogens risk percentage in CAUTI. |
|---|---|
| *Escherichia coli* | 23.9% |
| *Candida spp* | 17.8% |
| *Enterococcus spp* | 13.8% |
| *P. aeruginosa* | 10.3% |
| *Klebsiella spp* | 10.1% |
| *Other pathogens* | 6.4% |
| *Yeast NOS* | 6% |
| *Proteus spp* | 4% |
| *Enterobacter spp* | 3.7% |
| *CN staphylococci* | 2.4% |
| *S. aureus* | 1.6% |
| *Bacteriodes spp* | <0.1% |

Antimicrobial agents have different susceptibilities.

Table 02 – urinary catheter coating material and their susceptibility.

| Coating agent | Susceptibility |
|---|---|
| Silver | <99% |
| Antibiotics | Zone of inhibiton for more than 100 days |
| Chlorhexidine | <work 15 days |
| Triclosan | <24 days |
| Antimicrobial Peptides | ~4 days to 21 days |
| Enzyme | Act on targets |

| | |
|---|---|
| Nitric oxide | $<2X10^2$ CFU $ml^{-1}$ |
| Polymetric coating modifications | 6h to 42h |
| Liposomes | 3 to 5 days |
| Polyzwitterions | Reduce 80% biofilm formation |
| Baeriophagesct | Reduced by 4 log CFU |

## Conclusion

There are different antimicrobial urinary catheter coating agents are used to prevent urinary tract infections such as silver, antibiotics, chlorhexidine, triclosan, antimicrobial peptides, bacteriophages, enzymes, nitric oxide, polymeric coating modifications, liposomes, and polyzwitterions etc. These antimicrobial agents have a very high effect on killing pathogenic microorganisms. Catheter cleaning and maintenance is very important for preventing hospital associated CAUTI. Catheter associated urinary tract infection risk can be minimized using these antimicrobial agents. These antimicrobial agents have different susceptibilities. Silver has 90% susceptibility and liposome has 3 to 5 days. The enzymes act on targets and antibiotics susceptibility is more than 100 days. But in this case recommend silver antimicrobial agent to minimize catheter associated urinary tract infection risk. Because silver can protect from different microorganisms such as bacteria, viruses, protozoa, and fungi etc. the other reasons are silver has low toxicity to human cells, and silver has good antibiotic resistance. Silver has long lasting effectiveness. The other reasons are silver has very good stability in various environments, therefore patients can use this antimicrobial agent in various environments. Silver can be effective in low concentrations, and it can prevent biofilm formation. Silver can be used for different applications such as it can use with different materials, and it can use for medical device. Therefore, it has high adaptability. Under these recommendations this study recommends silver antimicrobial agent.

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# HAEMATOLOGICAL ABNORMALITIES IN HIV-INFECTION PATIENTS

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## Abstract

Human Immunodeficiency Virus (HIV) infection is a major problem whereas more than 4 million people worldwide are currently infected. If not treated, this can lead to the development of Acquired Immune Deficiency Syndrome (AIDS), a medical disorder characterised by the gradual impairment of the immune system, creating an environment conducive to the proliferation of potentially deadly opportunistic infections and malignancies. The aim of this study is to systematically review and analyse existing literature on haematological changes in HIV infection. Identification of haematological alterations aids helps in the diagnosis of opportunistic infections, cancer, and disease progression. Correcting haematological abnormalities can reduce complications and improve quality of life. The most relevant 10 articles out of 83 articles published in the last 15 years in the PubMed database were selected by focusing on experimental studies, randomised controlled trials, and other drug experimental research. Anaemia, leukopenia, thrombocytopenia, lymphopenia, and CD4 cell count were the most common haematological variations in HIV-infected persons. Other common haematological changes, Mean Cell Volume; Mean Cell Haemoglobin; Mean Cell Haemoglobin Concentration; and, Red cell Distribution Width, were detected. Compared the haematological abnormalities selected from the literature of HIV-positive patients before and after treatment with Highly Active Antiretroviral Therapy (HAART) for 6 months. As a result of the HAART haematological variation, significant improvement was observed. According to the results of several trials, notably those conducted in Ethiopia and Nigeria, HAART appears to benefit anaemia in HIV-positive individuals.

**Key words:** Haematological abnormalities, HIV, infected patients

**Extended Abstract**

## 1. INTRODUCTION

HIV infection is a severe public health problem and HIV/AIDS infects currently 34 million individuals worldwide(Chitra et al., 2019).HIV refers to a family of lentivirus species that can infect humans and belong to the retrovirus subgroup. This retrovirus's genetic material is RNA. This virus converts its RNA into DNA within the cells of its host via the enzyme reverse transcriptase(Klimas, Koneru and Fletcher, 2008). HIV is classified into two main types: HIV-1 and HIV-2. HIV-1 is the most common and widely dispersed type, but HIV-2 is more widespread in the West African region. HIV infection is a multi-stage process that involves delicate interactions with the immune system. When HIV infiltrates the human body, it primarily targets CD4+ T cells, which are important components of the immune system(Evans and Scadden, 2000). Anaemia, leukopenia, neutropenia, thrombocytopenia, coagulopathy, and other symptoms come from the damage to almost every cell generation in the bone marrow(Chitra, Manipriya and Deepa, 2019). Anaemia is the most prevalent haematological disorder. Anaemia affects between 63% and 95% of the population. Anaemia is caused by a breakdown in iron metabolism and utilisation, medicines, a lack of vitamin B12, and opportunistic infections. The main complication of HIV infection is chronic disease anaemia(Evans and Scadden, 2000).Anaemia raises the risk of death and is unrelated to CD4 count or viral load. Correction of anaemia is associated with decreased mortality and improved quality of life. A small increase in haemoglobin (2 g/dl) can improve quality of life(Chitra, Manipriya and Deepa, 2019). Histiocyte proliferation and phagocytosis of marrow blood cell progenitors characterise hemophagocytosis. Peripheral blood smears from HIV-infected patients show anisocytosis, poikilocytosis, Rouleaux formation, neutropenia, lymphopenia, and monocytopenia(Evans and Scadden, 2000). HIV infection affects millions of people globally, and haematological changes have an impact on overall health and treatment options. However, a better understanding of these changes, their clinical ramifications, and information gaps is required. This understanding is essential for designing personalised treatment programmes and enhancing public health. To examine these gaps, enhance medical care, and combat the HIV/AIDS epidemic, a complete desk research is required.

## 2.METHODOLOGY

### Information sources, and search strategy

The PubMed database was searched for research articles on haematological abnormalities in HIV-infected patients over the last 15 years used key terms. A flowchart was created from 89 relevant articles, assessing the clinical importance of these abnormalities in HIV-infected and HIV-uninfected patients using two methods.

### Haematological parameters variation of HIV-infected and HIV. -uninfected patients

HIV-infected patients have a wide range of haematological characteristics, including anaemia, neutropenia, and thrombocytopenia, all of which are frequent blood disorders associated with the virus.

### HAART (high-active antiretroviral therapy) before and after haematological parameters in HIV-infected patients

HAART is a treatment regimen for HIV that uses a combination of medications to reduce virus replication and immune system influence. It is effective in strengthening immune function and preventing AIDS progression. HAART can improve overall health and sometimes eliminate haematological abnormalities, but some may still experience them.

The relevant research was conducted in eight different countries. This study includes the vast majority of HIV patients in the African population. Understanding HIV-infected individuals' haematological abnormalities by evaluating haematological variance in both HIV-infected and uninfected people This method allows for a direct comparison in order to better understand the impact of HIV on haematological markers.

## 3.RESULTS AND DICUSSION

The most prevalent haematological markers found in the publications were Hb, total WBC count, platelet count, and CD4 cell count. HIV infection is connected to a number of haematological problems, including anaemia, leukopenia, and thrombocytopenia, according to this research. Highlighted the possible role of HAART in improving key haematological indicators in HIV patients.

Table 01 compares haematological parameters in HIV-infected patients before and after treatment with HAART. After 6 months of HAART treatment, haemoglobin levels increased, indicating an improvement in anaemia. The WBC count fell, possibly indicating a decrease in immune system activity or inflammation. The patient's platelet counts increased, indicating that thrombocytopenia, a typical HIV symptom, was improving. The CD4 count developed significantly, indicating that the immune system's effectiveness had improved. The mean value of haemoglobin and red cell indices (MCV, MCH, and MCHC) increased significantly at the commencement of HAART in HIV/AIDS patients. Before and after HAART, there were substantial differences in total WBC count, neutrophils, lymphocytes, Hb, MCV, MCH, MCHC, and platelets.

The variation in haemoglobin (mean SD) adults' group and white blood cell levels between HIV-positive and HIV-negative groups is illustrated in Figures 01 and 02, respectively. Figure 02 depicts this by comparing the two groups of HIV-positive and HIV-negative people. Hb levels differ significantly between different populations. Hb is a component of red blood cells, and changes in its levels might indicate anaemia or other health issues. Figure 03 depicts two sets of data points, one for HIV-positive people and one for HIV-negative people. The purpose of this graph is to show if there are significant variations.

*Table 01 Comparison between before and after HAART*

| Hematological parameter | Before HAART treatment (Mean SD) | After HAART treatment (6 months) (Mean SD) |
|---|---|---|
| Hb (g/l) | 12.9±2.05 | 14.17±1.75 |
| WBC (×$10^9$ /l) | 6.5±2.4 | 5.1±1.2 |
| PLT (×$10^9$ /l) | 268±85.2 | 300±83.6 |
| CD4 (Cells/mm3) | 161±106.5 | 381.2±190.9 |
| TLC (×$10^9$ /l) | 2.5± 0.8 | 2.3±0.7 |
| MCV (fl) | 87.17±3.51 | 100.67±4.9 |
| MCH (pg) | 28.75±3.19 | 34.04±4.15 |
| MCHC (g/dl) | 32.86±2.03 | 33.89±1.83 |
| ANC (×$10^9$ /l) | 3.1±1.8 | 1.9±1.6 |

(Abbreviations-WBC, white blood cell; TLC, total lymphocyte; ANC, absolute neutrophil count; Hb, haemoglobin; MCV, mean cell volume; MCH, mean cell haemoglobin; MCHC, mean cell haemoglobin concentration; RDW, red cell distribution width, PLT, platelets; CD, cluster of differentiation.

**Figure 01 : Total WBC variation HIV-positive group Vs HIV-negative group**

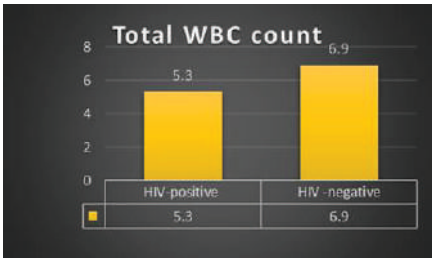
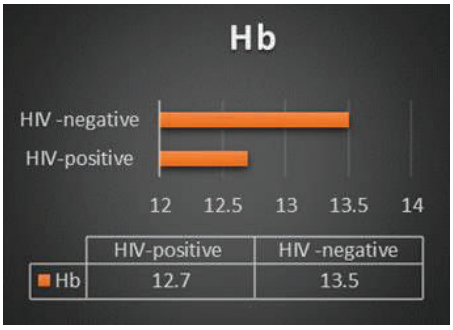



**Figure 02: Haemoglobin concentration HIV-positive group Vs HIV-negative group**




Anemia is a prevalent hematological anomaly in individuals living with HIV and is often a marker of the advancement of the illness. It is essential to understand the frequency of anemia in various groups to customize care and treatment plans. HAART appears to benefit anemias in HIV-positive patients by raising hemoglobin levels, which can improve patient outcomes and survival. Thrombocytopenia, a frequent hematological disorder seen in HIV-positive people, is characterized by a low platelet count, which calls for close observation and treatment. Numerous investigations have reported a correlation between CD4 levels and hematological disorders, such as anemia and lymphopenia. These abnormalities can cause anemias, leukocytopenia, and an elevated erythrocyte sedimentation rate (ESR), resulting in symptoms such as fatigue, increased vulnerability to infections, and inflammation. The study aimed to assess the clinical significance of hematological changes in HIV-infected patients through the analysis of hematological parameters in both HIV-infected and uninfected individuals. The findings have significant public health implications, as they can inform HIV/AIDS-related healthcare policies, resource allocation, and public health initiatives. Tailored healthcare measures based on these findings can mitigate the impact of HIV on affected populations, especially in regions where the disease remains a major public health concern.

## CONCLUSION

The combined results of these investigations highlight how crucial it is to keep an eye on haematological parameters in people living with HIV. Haematological disorders, such as thrombocytopenia and anaemia, are prevalent in HIV patients and can have serious clinical ramifications The study emphasises the importance of monitoring haematological parameters in HIV patients, as early HAART initiation can reduce anaemia and improve prognosis. It emphasises the need for holistic treatment, considering viral load and the haematological system, and the need for tailored care for different HIV-affected populations. In addition, investigating the impact of HAART on haematological indicators before and after treatment sheds light on the potential benefits of therapeutic interventions.

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# EFFECTENESS OF OPERATIVE TIME ON POST-OPERATIVE WOUND INFECTION IN ORTHOPAEDIC SURGERY.

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## Abstract

Surgical site infection is one of the most frequent side effects following orthopaedic and other surgeries. The SSI following implant surgeries is a catastrophe in orthopaedics for both patient and surgeon. Therefore, it is crucial to investigate and validate the reasoning behind the actual causes of PWI following orthopaedic surgeries. This study aims to identify whether a longer operative time in orthopaedic surgery is an independent risk factor for PWI. The nine most relevant original articles have been extracted from 918 studies by searching PubMed and CINAHL databases using the terms “surgical site infection”, "post-operative wound infection”, "orthopaedic,” and “operative time”. The selected retrospective and prospective studies were published in English within the last 10 years (2013–2023). More than 103600 cases treated by four types of orthopaedic surgeries, such as open reduction and internal fixation for the ankle, distal femur, tibial plateau, total knee and hip arthroplasty, knee and shoulder arthroscopic procedures, and spine fusion, were evaluated in this systematic review. After analysing the results, the author has identified a positive correlation between operative time and PWI in each type of surgery. As a final conclusion, the authors suggest that operative time is an independent risk factor following orthopaedic surgery. further identified risk factors for SSI and risk factors for longer operative duration. This knowledge will allow health care workers in orthopaedic theatres to take preventive measures to minimise PWI and longer operative durations.

## 1.Introduction

Orthopaedic surgery is a branch of medicine that focuses on the treatment, diagnosis, and prevention of diseases, accidents, and disorders that impact the musculoskeletal system. There are many subspecialties in orthopaedic surgery, such as hand and upper extremity, foot and ankle,

podiatry, pediatric orthopaedics, spine surgery, trauma surgery, joint replacement surgery, orthopaedic oncology, including tumor and cancer care, and sports medicine. In this surgery, they used various metal implants to fix the bones. Use Plates, screws, pins, and rods to fix a fracture. Repairing ligaments with healthy tissues from another part of the body, donor grafts, and metal and plastic implants for arthritic joints are needed in general orthopaedic procedures Previous conservatively managed bone injuries are now being increasingly treated surgically because of an advancement in orthopaedic techniques, and the risk of post-operative wound infection relates to orthopaedic complexity, the use of implants, and increased orthopaedic indications.

Infection at the surgical site (SSI) is one of the most frequent side effects following orthopaedic and other surgery. SSI associated with orthopaedic surgery is regarded as serious, and amputation of the limb or even death can result as a complication. In nurses' clinical practice, it is important to identify connections between SSI and risk factors. By involving patient preparation and targeted intervention for potential risk factors, infections should be avoided to minimize post-operative complications A prolonged OT lengthens the surgical field's exposure to the environment, theoretically, it could cause an increase in SSI because of the increased risk of contamination. There is little evidence to prove the common belief that prolonged OT increases PJI, and these studies have significant limitations There is no literature regarding OT effect on SSI following all orthopaedic surgeries. The aim of this study is to identify whether a longer operative time in orthopaedic surgery is an independent risk factor for post -operative wound infection. The author connects each study together in this review and provides more solid evidence for the effects of prolonged OT and the risk of SSI in orthopaedic surgery.

## 2.Methodology

In this systematic review, all literature related to the effect of OT on PWI in each kind of orthopaedic surgery was collected in various databases and analysed. The search of literature was performed in PubMed and CINAHL (OBU e library resource) databases to find journals and articles related to the topic. The selected journal articles were published within present 10-year period (2013–2023) in English language. The key words were "post-operative wound infection", "orthopaedic ", "surgical site infection", "operative time", "surgical duration". “AND” and “OR” are used as Boolean operators to get the appropriate literature.

A total of 918 records were obtained after the removal of duplicate articles. 98 full text articles were reviewed for inclusion. 89 articles were excluded, and nine articles were included in the study after a full-text assessment for eligibility. The following inclusion criteria were used: relationship between OT and SSI or PWI was evaluated in orthopaedic surgery, articles that were published in English only; articles published within the past 10 years (2013–2023); and at least one article for each type of orthopaedic surgery. Selected nine articles were retrospective or prospective studies and analyzed quantitative data to give an answer to each research question.

## 3.Results and discussion

Table 1: Summery of the nine articles

| Study | Author | Year | Type of surgery | Findings |
|---|---|---|---|---|
| 1 | Colman et al | 2014 | Fracture | Identify independent risk factors for PWI<br>OT significantly longer in infected group than non-infected group |
| 2 | Gowd *et al* | 2020 | Fracture | OT significantly associated with SSI |
| 3 | Xu *et al* | 2019 | Fracture | Prolonged surgical duration has identified as independent risk factor for SSI |
| 4 | Anis *et al* | 2019 | Arthroplasty | Identified factors affect to OT<br>OT had significant effect on PWI and PJI |
| 5 | Teo *et al* | 2018 | Arthroplasty | Risk of infection in TKA was significantly associated with a longer operative duration. |
| 6 | Wang *et al* | 2019 | Arthroplasty | Prolonged operative time is an independent risk factor for postoperative infection |
| 7 | Agarwalla *et al* | 2019 | Arthroscopy | Adverse risk rate after ACL reconstruction remains low, marginal increases in operative time are associated with an increased risk of adverse events such as surgical site infections, sepsis |

| | | | | |
|---|---|---|---|---|
| 8 | Boddapati *et al* | 2018 | Arthroscopy | Increased shoulder arthroscopy procedure time is associated with superficial SSI and overnight hospital stay |
| 9 | Kim *et al* | 2014 | spine | Increasing operative time associated with complications including SSI |

All the selected articles for this review are quantitative studies. Selected articles can be categorised under the type of surgery as fracture surgeries, arthroplasty surgeries, arthroscopic surgeries, and spinal surgeries as shown in table 1. This systematic review contents nine articles related to four types of orthopaedic surgery. Three studies related to arthroplasty, three studies related to ORIF after trauma, two studies related to arthroscopic procedures, and one study related to spine fusion surgeries are included in the study.

Effect of operative time on SSI

The purpose of this systematic review was to identify the impact of increasing OT on post-operative wound infection following orthopaedic surgery. The author used thematic analysis according to the surgery type to get an answer for research question.

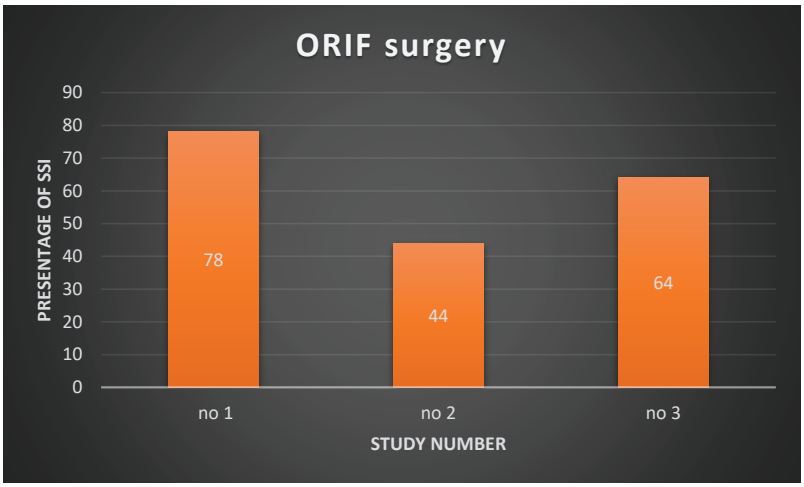


Figure 1: Rate of SSI according to OT in ORIF

Figure 1 shows the rate of surgical site infection for every one hour of increasing operative time in the ORIF surgeries related studies. In the study of Colman, infected group operative

time duration was 2.8 hours and time duration of non-infected group was 2.2 hours. There was 36 minutes time gap between two groups and for bicondylar fractures the gap between infected and non-infected groups was 42 minutes (3.2 hour-2.5 hour), for unicondylar fractures the gap between infected and non-infected group was 18 minutes (2.2 hour-1.9 hour) The study results of Colman et al. demonstrated that longer operative times were a predictor of SSI in tibial plateau surgeries. Furthermore, they have identified that every extra hour of OT increases the infection rate by 78% in the same operative protocol and same clinical setting for all surgeries. In the study of Gowd *et al.* has identified that a 15-minute increase in OT is associated with an increased risk of SSI by 11% in their study of ankle fracture ORIF patients (RR: 1.11; 95% CI: 1.06-1.16) Xu *et al. (*2019 conducted a study of patients with distal femur fractures and identified OT as an independent risk factor for the development of SSI after adjustment of confounding variables and an extra 1 hour of surgical time, which increased the risk of SSI by 64% (OR 1.64; 95% CI 1.17–1.99). According to this chart there is a significant effect of operative time and increasing SSI has shown in orthopaedic trauma.

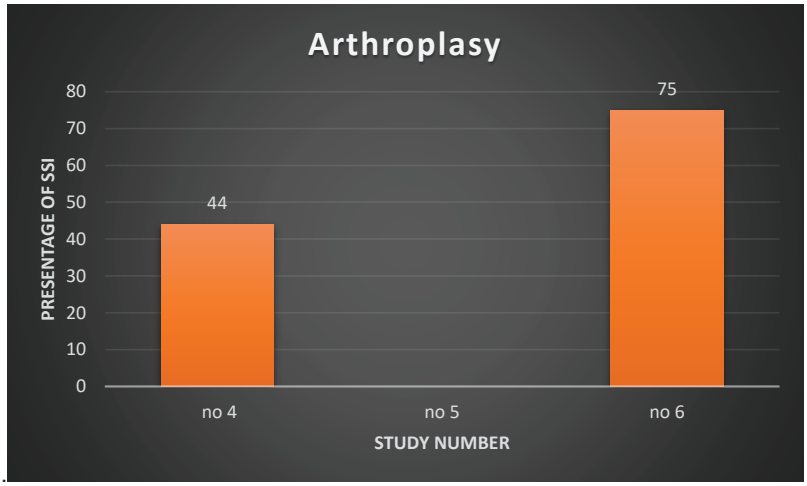


Figure 2: Rate of SSI according to OT in arthroplasty

Figure 2 shows the rate of surgical site infection for every one hour of increasing operative time in the primary total joint replacement surgeries. In the study of Anis et. al. the gap between OT was 30 minutes (135±47 vs105±32) between infected and non-infected group complicated by PJI and 10 minutes (115±39 vs105±31) gap between infected and non-infected

group complicated by SSI. They have identified every 15 minutes an increase in OT, an increase in the risk of PJI by 18%, and an increase in the risk of SSI by 11%. Wang *et al.*

Conducted a study on both TKA and THA patients and demonstrated an independent correlation between OT and PWI, both SSI and PJI, by analysing their results. Furthermore, they have proven that every 20 minutes of OT increases the risk of PJI by 25% after controlling for the confounding effects of other factors.

Studies of Anis et al. and Wang et al. only investigated the increasing percentage of SSI related to OT. Though Teo et al. concludes that there is a significant effect of OT on SSI but they were unable to provide sufficient amount of percentage values. Nevertheless, it can be identified increasing OT significantly affecting in arthroplasty surgeries.

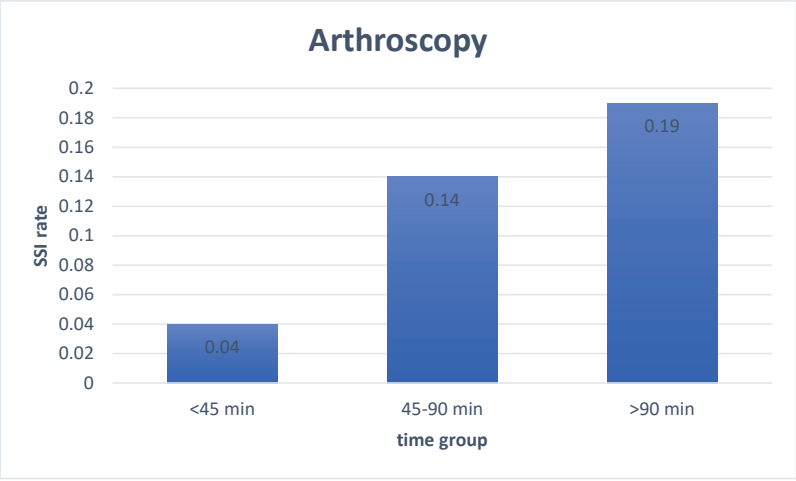


Figure 3: SSI rate according to time group in arthroscopy

connection between operating time group and superficial SSI rate following shoulder arthroscopic surgeries are shown in figure3. There is 0.15% increasing gap between <45 minutes OT group and >90 minutes time group. It can be considerable amount when comparing large sample size more than 33000. Therefore, it was a positive correlation between longer OT and risk of SSI after arthroscopic procedures.

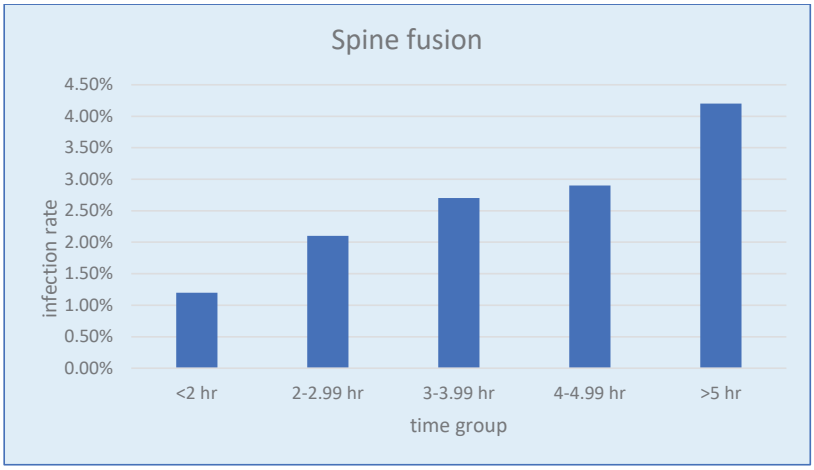


Figure 4: SSI rate according to time group in spine fusion

Figure 4 shows five operative time groups of the spinal fusion and the SSI rate increasing rate. It can be identified significant increasing SSI rate according to increasing surgical duration.

According to the thematic analysis, increased operative time increases risk of SSI after orthopaedic surgeries. Tibial plateau ORIF, distal femur ORIF and ankle fracture ORIF, primary TKA and THA, shoulder and knee arthroscopic procedures, spine fusions surgeries were evaluated to answer this research question.

According to the four thematic analyses, a positive relationship between OT and SSI was identified.

Factors affecting SSI/PWI

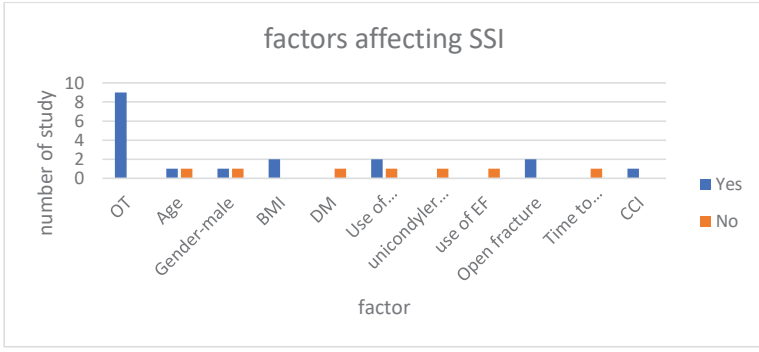


Figure 5: Risk factors and number of studies for SSI

To find the effect of operative time to PWI or SSI, all the studies evaluated factors affecting SSI or factors affecting operative time. After analyzing the factors affecting SSI, the author has identified operative time is the significant effect to the SSI. And high BMI, use of tobacco or smoking, open fracture are the other factors for SSI (figure 5).

Factors affecting longer operative time

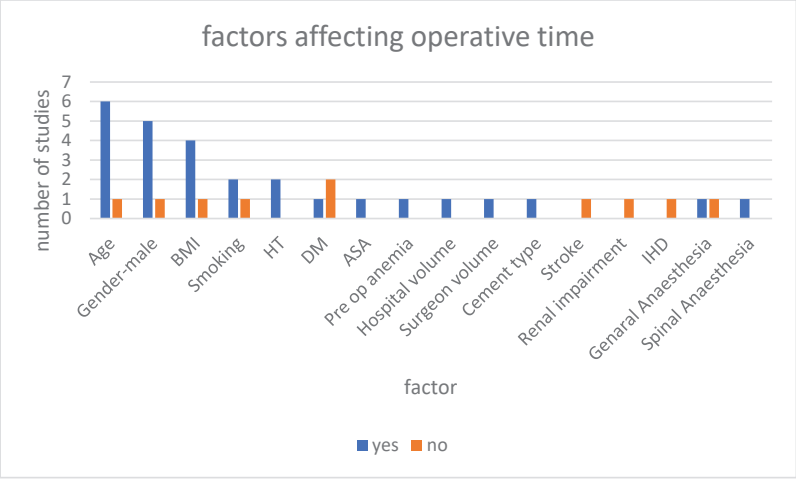


Figure 6: Risk factors and number of studies for OT

Most of the studies evaluated factors for longer operative time. The author has identified, age, male gender, high BMI, smoking, and hypertension are the factors affecting operative time.

## 4.Conclusion

As the operation theater is not a perfect germ-free environment, patient undergoing longer surgery will be subjected to higher exposure time which causes the SSI. As the most of study revealed by different authors, there is significant percentage of increase of SSI with related to the OT, regardless the other facts discussed in the discussion which lead to SSI, it can be conclude, but not generally there is chance of increase of SSI by approximately 61% when patient undergo surgery more than one hour. Preventive measures should be taken to minimise surgical duration without disturbing the surgical procedure or quality of care. Pre-operative patient optimisation, patient counselling, and improving operating room efficiency are the suggested measures to

minimise OT. Therefore, the author suggests more evidence to investigate the best measures to decrease SSI and surgical duration.

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8th iNTERNATIONAL CONFERENCE ON MULTIDISCIPLINARY RESEARCH 2023

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## 8th INTERNATIONAL CONFERENCE ON MULTIDISCIPLINARY RESEARCH 2023

Session 02

**Computing**

# SmartGrid Nexus

## Electricity Meter Management System Using IOT Technology for Domestic Environment

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### Abstract

Efficient management of energy and water resources is imperative for sustainable development, both environmentally and economically. This paper addresses the challenges faced by utility boards, particularly the National Water Supply and Drainage Board and the Ceylon Electricity Board in Sri Lanka, where analog meters have been traditionally used. The analog meters pose significant operational costs due to monthly meter readings and billing processes. Despite the established use of analog meters, the Ceylon Electricity Board has made strides in transitioning to digital meters, enhancing the efficiency of meter reading and billing processes.

The paper delves into key statistics, such as the substantial growth in electricity sales, reaching 15,214 GWh in 2021, compared to 14,286 GWh in 2020. The surge in consumer accounts by 173,262 from 2020 to 2021 underscores the increasing demand for electricity. The annual growth of 2.6% in consumer accounts and the rise in monthly additions highlight the dynamic nature of the utility landscape.

The proposed smart metering system aims to empower consumers by providing real-time insights into their electricity usage, fostering informed decision-making. Additionally, it envisions reducing the operational burden on utility boards through automation and remote monitoring. However, the paper acknowledges potential challenges, including health and security concerns, emphasizing the importance of addressing these issues for successful implementation.

In conclusion, the paper outlines the aims and objectives of the project, which include reducing peak power generation charges and enhancing consumer engagement in off-peak hours. The proposed system integrates hardware components, cloud architecture, and advanced functionalities like real-time registration and remote accessibility. Finally, the research identifies the key requirements, skills, challenges, and a project timeline, offering a comprehensive overview of the proposed smart metering solution for sustainable energy and water management in Sri Lanka.

## Extended Abstract

### 1. Introduction

In our daily lives, the use of electricity and water is so ingrained that it's easy to overlook the intricate systems that enable their supply. Yet, the management of these resources is crucial, not only for our convenience but also for the economic health of nations. This paper delves into the challenges faced by utility boards in Sri Lanka, particularly the National Water Supply and Drainage Board and the Ceylon Electricity Board, as they grapple with the demands of an ever-growing population.

Energy conservation is a topic that resonates with everyone. It's not merely a matter of flipping a switch; it's about understanding the intricate balance between supply, demand, and the financial implications involved. The reliance on analog meters has been a longstanding practice, but it comes with its share of challenges, particularly in the monthly meter reading and billing processes. The National Water Supply and Drainage Board, from its inception, has grappled with the expenses tied to analog meter usage, shedding light on the inherent need for a more streamlined and cost-effective system.

Similarly, the Ceylon Electricity Board's journey from analog to digital meters reflects a broader shift in the utility landscape. The transition is not just a technological upgrade; it represents a response to the increasing complexities of managing energy resources in a rapidly evolving world. The meter readers, tasked with the responsibility of reading and processing meter values, face challenges in covering specific regions efficiently. It's a delicate dance between increasing electricity and water usage and the escalating costs associated with managing and monitoring these processes.

Understanding the scale of electricity consumption provides a snapshot of the magnitude of the challenge. In 2021 alone, electricity sales reached a staggering 15,214 GWh, a notable increase from the previous year. The average daily sale of 42 GWh highlights the constant demand that utility boards must navigate. Moreover, the surge in consumer accounts by 173,262 from 2020 to 2021, with a monthly average of 14,438 new accounts, underscores the growing need for efficient and scalable solutions.

The global landscape offers insights into potential solutions. European countries have already embraced digital metering systems, incorporating SMS/APP technology. The paper proposes a similar shift in Sri Lanka, tailored to its unique context. However, this isn't just a technological upgrade; it's a shift towards empowering consumers with information. Many consumers remain unaware of how their energy and water consumption patterns impact both their wallets and the broader utility landscape.

The global smart meter market's growth, projected to reach $65.31 billion by 2032, emphasizes the urgency and potential benefits of adopting advanced metering technologies. The proposed solution aims to provide consumers with a tool to track their electricity usage in real-time, fostering a sense of responsibility and informed decision-making. Simultaneously, it envisions reducing the operational burden on utility boards through automation, ultimately contributing to the reduction of peak power generation charges.

While the proposed smart metering system promises numerous advantages, it also acknowledges potential challenges. Health and security concerns, as well as the necessity for cost-effective solutions, are crucial aspects that must be addressed for successful implementation. This paper unfolds the aims, objectives, and the multifaceted components of the proposed smart metering system, offering a comprehensive exploration into the evolving landscape of energy and water management in Sri Lanka.

## 2. Methodology

Saving energy and water becomes vital and isn't free. Electricity and water waste are the same as financial waste. The National Water Supply and Drainage Board has employed Analog meters since it was established and faces substantial expenses for monthly meter readings and billing. Ceylon Electricity Board utilized Analog meters earlier in the period than at the time of installation, Digital meters. To read the meter values and give customers the previous month's bill, meter readers are given a particular region to cover.

The total Electricity Sales (billed) in the year 2021 was 15,214 GWh. The corresponding figure in 2020 was 14,286 GWh. Average daily sale of electricity for the year 2021 was 42 GWh/day. The total number of consumer accounts (billed) in 2021 has increased by 173,262 from 6,636,266 in 2020 to 6,809,528 in 2021, showing annual growth of 2.6%. Monthly average of the new consumer accounts added to the system in 2021 was 14,438 as against 11,302 in the previous year.

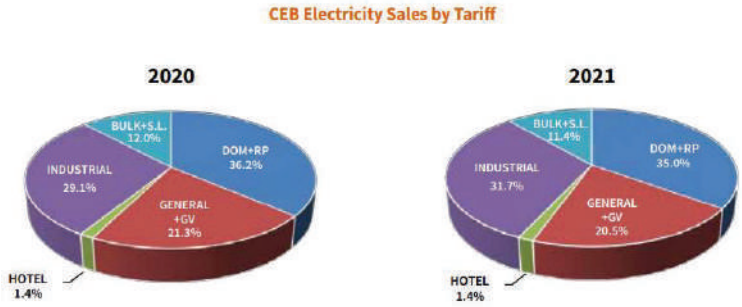


Figure 1: CEB Electricity Sales by Tariff

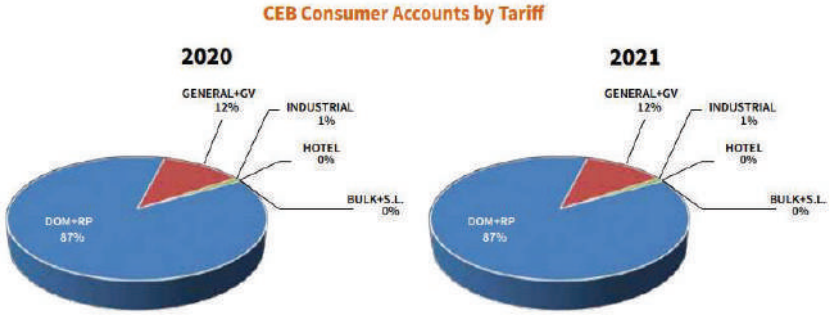


Figure 2: CED Consumer Accounts by Tariff

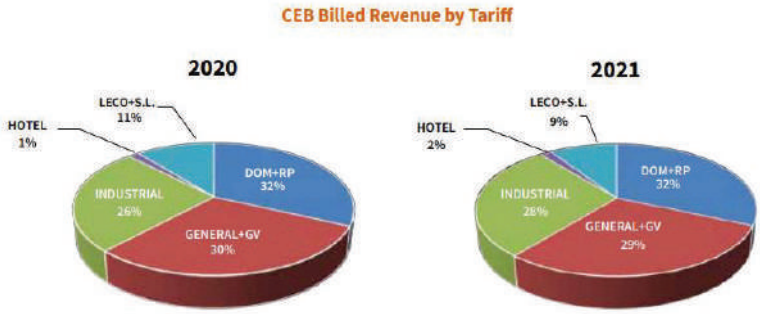


Figure 3: CEB revenue by Tariff

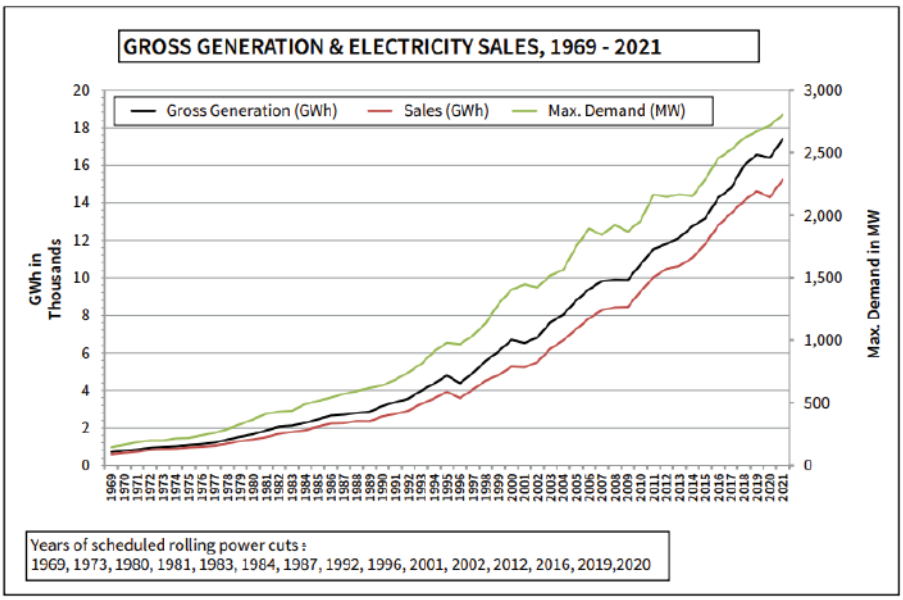


Figure 4: Historical Behaviour Pattern, 1969-2021

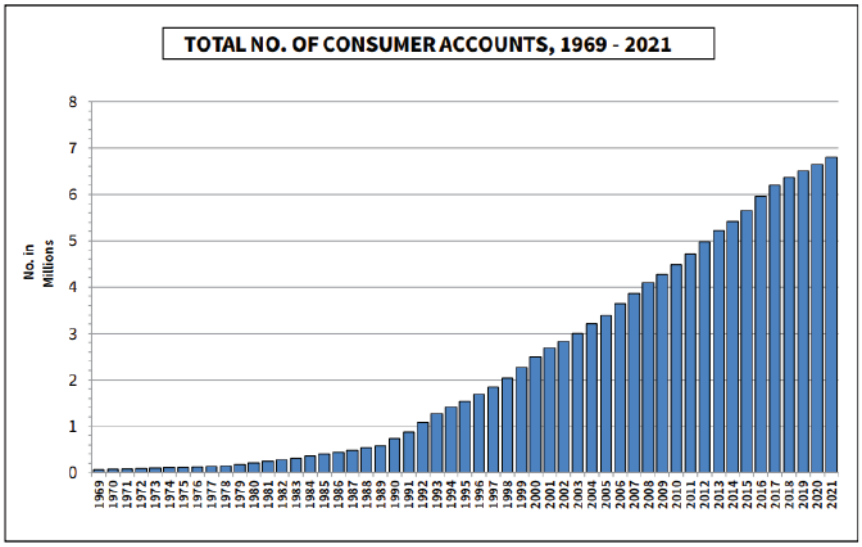


Figure 5: Total No. of Consumer Accounts, 1969 - 2021

Each authority was assigned its own officers to read the meter values. On one hand, it increases the usage of electricity and water, on the other hand, it increases the expenses of reading, managing, and monitoring the process.

According to CEB officials, some read as many as 60- 200 metres a day. Meter readers average wage over 100,000 – 150,000 rupees **(EconomyNext, 2017).**

European countries already use the digital meter system with SMS/APP technology, and the proposed solution will analyse and design to suit the Sri Lankan context. Unfortunately, existing systems do not benefit from decreasing the quantity of electricity and water used by customers to reduce their operating expenses. Customers are unaware of how energy and water meters are now used to reduce and balance consumption in terms of both value and money.

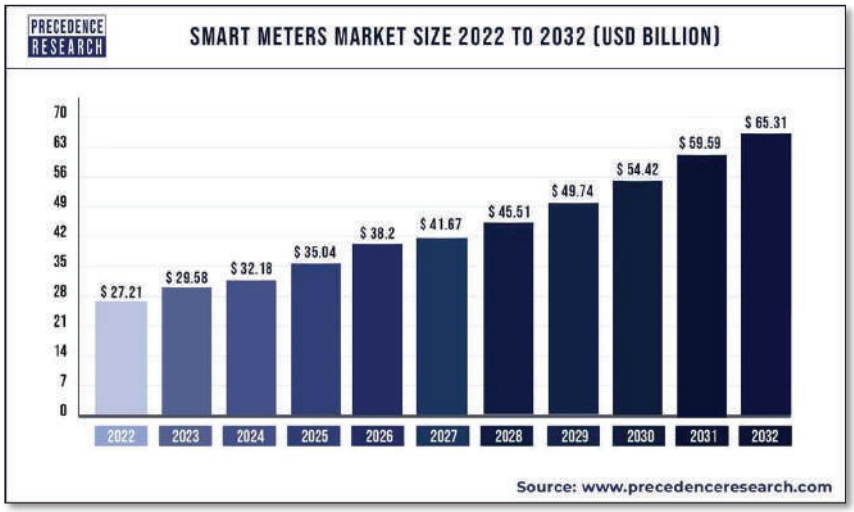


Figure 6: The global smart meters market size was valued at US$ 27.21 billion in 2022 and is expected to hit US$ 65.31 billion by 2032, growing at a CAGR of 9.20% from 2023 to 2032.

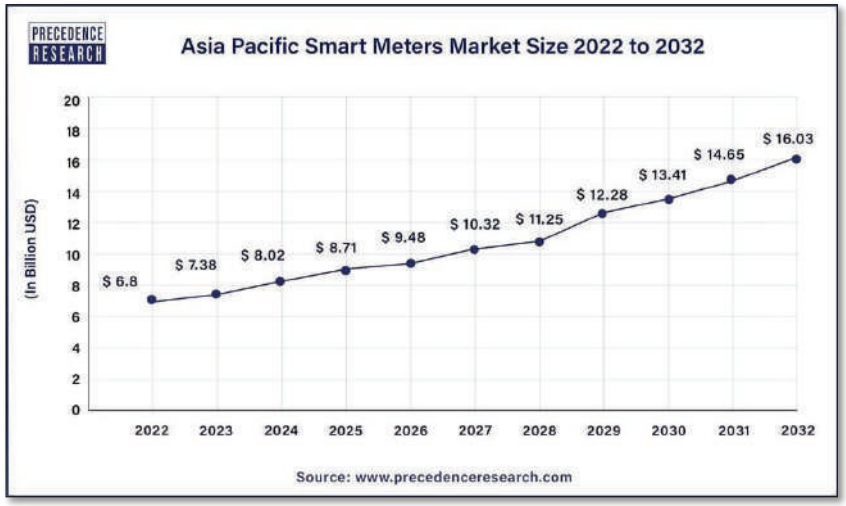


Figure 7: Smart Meters Market in Asia-Pacific 2023 To 2032

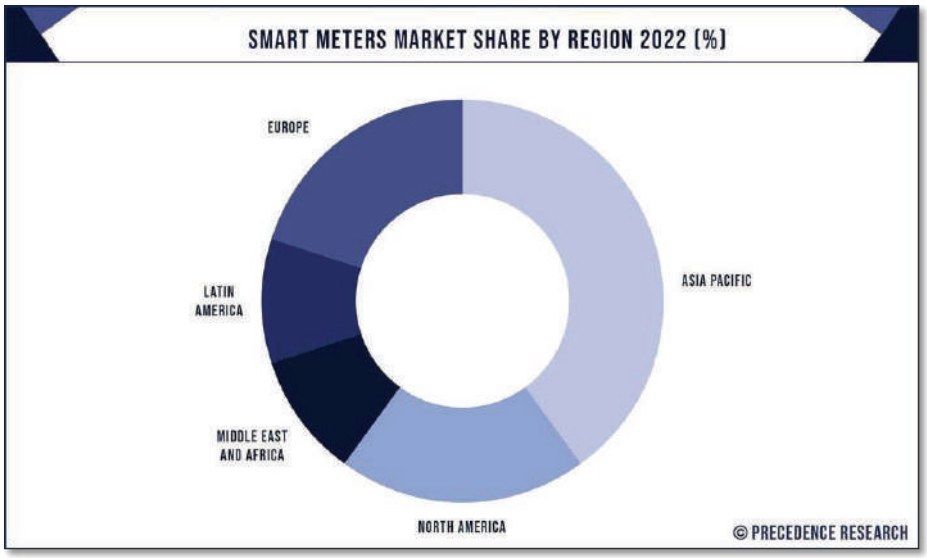


Figure 8: Smart Meter Market Share by Region 2022

Meter readers are experiencing sophisticated issues when they reach domestic consumers such as domestic animals, unavailability of the occupants, influences, and inaccurate reading which will lead to a financial loss to the consumer as well to the authority. Ceylon Electricity Board introduced electricity meter with different features time to time as follows.

Figure 9: Recently introduced Automated Meter Reader a smart meter.

At present in Sri Lanka, most of the bulk consumers already use advance electronic meters, since the electricity tariff scheme introduced in 2011 has included the Time of Use (TOU) tariff for the industries. These meters are comprised with only few smart functions, which are energy usage recording & storage facility accordance with the defined time slots and remote reading facility. Nevertheless, the remote reading facility of these meters is still used only in Colombo City region. The approximate cost of this type of electronic meter with remote reading facility is Rs.25,000 and without the remote reading facility the cost is around Rs.15,000. **(Applicability of Smart Metering Technology in Sri Lanka Prepared By: Public Utilities Commission of Sri Lanka Content, n.d.)**

## 3. Results and Discussions

**Necessity of introducing Smart Meters to Sri Lanka**

During the first half of year 2012, 64% out of total electricity generation in Sri Lanka has been catered by expensive fossil fuel oil power plants. Most of these plants have been operated only to meet the steep night peak. Sri Lanka has a daily load curve with a steep peak in the night, where starting from about 6.00 pm the load grows to about 2,000 MW by 7.30 pm and starts falling off after about 08.30 pm. Therefore, the system must be comprised of a substantial additional

generation capacity only to meet that abrupt sharp night peak which is a huge burden for Ceylon Electricity Board (CEB).

Smart metering systems are comprised of two main components:

- Advanced electronic meter module (Smart Meter)
- Communication network with the ability of remote communication.

These meters have the ability to transmit the data to flow from meter all the way to utility and vice versa, in real time speed through commonly available fixed networks such as Broadband over Power Line (BPL), Power Line Communications (PLC) or Fixed Radio Frequency (RF) networks.

**Anticipated Benefits**

- Automatic Meter Reading (AMR) Facility
- Outage Detection Ability
- Prepayment Facility
- theft of energy
- Financial benefits
- TOU Tariff
- Reduce the demand growth and Reducing Carbon footprint.

**Key Challenges to Implementation of Smart Meters in Sri Lanka**

Technical Challenges

The existing electricity system in Sri Lanka does not support both demand side management and decentralized power generation, since much of the transmission and distribution infrastructure we have today, is more than 50 years old. This aging grid infrastructure is a huge barrier to deploy smart meters in Sri Lanka, since it doesn't support handling large amount of data. Therefore, the existing system must be upgraded, as well as a communication infrastructure also must be in place to support successful deployment of smart meters.

High Capital Cost

Although smart meters are one of the tools being considered to fight many issues in electricity networks, it is still an expensive alternative. An advanced smart meter might cost $250 in United States, but in a developing country the same device could cost $1,500 because of low volumes and necessary rewiring. A full-scale deployment of AMI requires expenditures on not only smart meters, but also all the other hardware and software components, network infrastructure and network management software, along with cost associated with the installation and maintenance of meters and information technology systems.

Consumer Resistance

Due to lack of understanding and knowledge among the public about the benefits over deploying smart meters and because of negative perceptions, initial resistance to the adoption of smart meter technology can be expected by consumers, as it represents a forced change in consumer lifestyle. Also, the consumers will be highly reluctant to offer their monetary contribution towards recovering the cost of meters. Therefore, consumer awareness regarding the merits of using smart meters and societal benefits is needed very much.

**(Applicability of Smart Metering Technology in Sri Lanka Prepared By: Public Utilities Commission of Sri Lanka Content, n.d.)**

Now, the demand for electricity has increased in the World. This demand was increased concern to the raises of many developed and developing nations in the world. In Sri Lanka, the energy was provided by only less electricity power stations. So, the scarcity of electricity has occurred

eventually. Thus, reducing and controlling power consumption will be responsible for all consumers. Furthermore, consuming data should be tracked by the consumer is essential now. But recently, consumers are using traditional meters in each home. It has failed to provide these facilities to the user. Moreover, Digital meter is trying to reduce these limitations. This research study focuses on a Smart Electricity Monitoring System using a mobile application. This is an IoT based project. The electricity consumption can be observed by the user through a user-friendly mobile app. And the monthly electricity bill has automated. This smart electricity meter system can be separated into three divisions, and the first system is the hardware setup using Arduino to measure electricity consumption at home. The real-time Alternate current and Alternate voltage through the hardware setup were measured through this system. By considering these values, the Alternate power will be generated. Then the real-time values were converted to units(kW/h) and sent to the database through Wi-Fi. The real-time database in Firebase was the other system. Storing real-time data and permitting them to retrieve them through the mobile application was the main function here. The final system is the user-friendly android application. This system aims to get more involvement of the consumer to their electricity consumption and reduce global electricity consumption. As the results can be observed through the mobile application, the user can get some idea of saving and reducing electricity than earlier. **(Fernando and Perera, n.d.)**

The solution, developed in collaboration with the Dialog Mobile Communications Research Lab at University of Moratuwa, converts a standard electronic meter into a smart meter which can maintain a prepaid wallet to facilitate prepaid electricity metering. The smart-grid solution is supported by a utility IoT and analytics platform and utility Meter Data Management (MDM) system, developed jointly by Dialog and LECO. The smart-grid solution also consists of a Network Monitoring Device (NMD) which monitors the low voltage power distribution network in real-time. This is the first IoT enabled prepaid meter in the utility sector in Sri Lanka, where consumers will be able to reload the electricity meter as and when convenient, like how a prepaid mobile is reloaded, rather than having to pay a monthly bill. It is also the first IoT initiative in the utility sector where an IoT platform has the capacity to connect smart meters and Network Monitoring Devices (NMDs) to a single platform, thereby providing flexibility and scalability to LECO. Moreover, prepaid electricity metering will benefit low-income communities and will be initially available in the LECO Green Energy Zone in Kotte. **(Dialog Axiata PLC, n.d.)**

## Cloud Architecture

The following diagram shows a consolidated view of architectural patterns that makes it easier and more reliable to transfer high-volume IoT data to the AWS Cloud. Stream manager processes data streams locally and exports them to the AWS Cloud automatically. This feature integrates with common edge scenarios, such as machine learning (ML) inference, where data is processed and analysed locally before being exported to the AWS Cloud or local storage destinations.

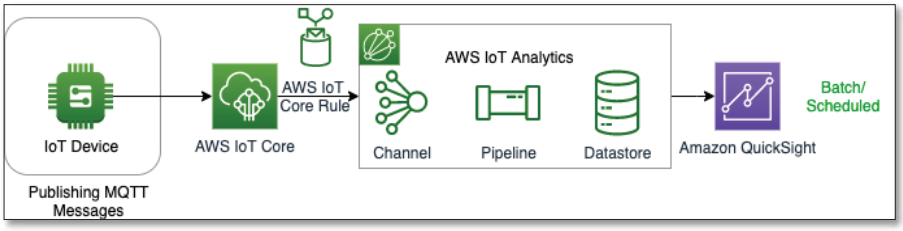


Figure 10: AWS IoT Core + AWS IoT Analytics + Amazon QuickSight

## Advantage of the proposed system

- Centralized solution to manage utility meters with less manpower.
- Easy to manage the Automated Meter without physically visit the site.
- Industries can have their own meters to control their energy usage within departments.
- Consumers benefited and updated with present electricity unit use and financial value.
- On time billing and collection.

### Challenges

The proposed solution poses several challenges, ranging from technical and security issues to interoperability and scalability. Few challenges as below.:

- Security Concerns
- Interoperability
- Scalability
- Data Management
- Power Consumption and Efficiency
- Device Management
- Privacy Concerns
- Cost Constraints
- Complex Ecosystem

## 4. Conclusions

Most of existing systems and technologies they are adept were reluctant to address the issues. The proposed solution is an answer for all the above drawbacks addressed. The proposed system can be extended to read the values and control from a central point directly instead of the meter reader. However, the meter reader can visit the domestic if suspicious of meter tampering. The proposed system will be a productive, efficient, user-friendly and cost-effective solution.

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# Smart EmoAssist, AI Powered Depression Detection and Support System

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## Abstract

In today's dynamic and challenging world, mental health issues, including stress, anxiety, and depression, have emerged as significant concerns affecting individuals worldwide. Sri Lanka, with its unique societal context, is not immune to these challenges, as evidenced by a growing demand for effective mental health support. This research project introduces "EmoAssist," a groundbreaking technological solution designed to address the pressing mental health needs of the Sri Lankan population. The project begins with a comprehensive exploration of the mental health landscape in Sri Lanka, highlighting the prevalence of stress, anxiety, and depression and the critical role of early intervention and support. It sheds light on the cultural and social factors contributing to the stigma surrounding mental health, which often hinders individuals from seeking assistance.

"EmoAssist" harnesses the power of artificial intelligence and natural language processing (NLP) to provide accessible, stigma-free mental health support. The app offers personalized recommendations, one-on-one chatbot interactions, and timely notifications, all designed to empower users on their mental health journeys. This research project not only contributes to the growing body of knowledge on technology-driven mental health solutions but also serves as a testament to the importance of tailored support systems in diverse cultural contexts. "EmoAssist" represents a significant step forward in advancing mental health care in Sri Lanka, offering hope and assistance to those who need it most.

**Keywords:** mental health, Sri Lanka, EmoAssist, technology, artificial intelligence, natural language processing (NLP), stigma, early intervention, cultural context, personalized recommendations, chatbot interactions, mental health support.

## 1. Introduction

In the face of unprecedented global challenges, mental health has become a paramount concern, with depression as a formidable adversary. The COVID-19 pandemic has intensified the urgency of addressing mental health issues, emphasizing the need for accessible and compassionate support systems. Sri Lanka, known for its rich culture and resilience, confronts a concealed epidemic of depression, particularly affecting its youth. Against this backdrop, the "EmoAssist" project emerges as a cutting-edge solution, leveraging technology to guide individuals towards mental well-being.

"EmoAssist" transcends the boundaries of a conventional application; it embodies a lifeline, driven by artificial intelligence (AI) and natural language processing (NLP), to provide compassionate and accessible mental health support. The research journey encompasses key areas, including the technological foundation of "EmoAssist," its functional and non-functional features, and its commitment to user privacy, security, and continuous improvement.

Central to our exploration is the understanding of how "EmoAssist" leverages AI and NLP technologies to engage in natural conversations, providing users with a safe space to express their emotions, thoughts, and concerns. Through conversational therapy, mood tracking, and a comprehensive resource hub, this application offers invaluable tools for individuals to better understand and manage their mental well-being. Moreover, the emphasis on peer support and immediate crisis intervention ensures that no one faces the burdens of depression alone. With privacy and security as paramount concerns, "EmoAssist" is designed to protect user data and foster an inclusive environment, while scalability and reliability guarantee that its benefits remain accessible to all who seek them.

This report explores the "EmoAssist" project, an innovative mental health support platform tailored to Sri Lanka's mental health needs. Employing advanced technologies such as artificial intelligence (AI) and natural language processing (NLP), "EmoAssist" aims to provide a listening ear, a helping hand, and a bridge to mental health experts. The report delves into the project's genesis, objectives, methodologies, and societal impact, highlighting its potential to destigmatize mental health, enhance early detection, and improve overall mental well-being in Sri Lanka.

## 2. Methodology

The selected methodology for this research project, focused on developing an AI-driven smart depression detection application platform, is motivated by the requirement for thorough data-driven insights and a well-organized project management approach. Within the realm of improving user experiences in the field of mental health, this methodology acts as the foundational framework for executing surveys, collecting user analytics, and conducting data analysis.

- **Quantitative Research Approach:** To address crucial research questions and objectives concerning user needs and preferences in the context of depression detection, a quantitative research approach is pivotal. This method involves the systematic collection and analysis of numerical data obtained from surveys and research in order to identify the shortcomings and gaps present in the field of mental health.

- **Data Collection:** The research methodology places significant emphasis on comprehensive data gathering from diverse sources to achieve a holistic comprehension of the mental health landscape. This encompasses the utilization of web-based surveys to capture user insights, employing AI-driven tools for tracking user interactions with other similar mental health tools, and collecting relevant statistics and data points from reputable mental health organizations and research studies.

- **Statistical Data Collection:** Surveys are an essential part of the approach and serve as useful tools for identifying user requirements, difficulties, and levels of satisfaction. This strategy fits with the project's goal of recognizing the needs and challenges experienced by people who are coping with depression. The survey data is crucial in defining the capabilities of the depression detection system and improving its precision and efficiency.

### 2.1 Development Methodology

The development methodology adopted for the "EmoAssist" project is a structured and adaptive approach aimed at creating a robust and user-centric mental health application. It combines elements of Agile and DevOps practices to ensure efficiency, flexibility, and continual improvement throughout the project lifecycle.

- **Agile and DevOps Methodologies:** Agile development involves iterative sprints with daily stand-ups, while DevOps focuses on continuous integration, automated deployment, infrastructure as code, monitoring, security, and scalability. User testing and feedback drive improvements, and the system is deployed to a secured cloud. Ongoing maintenance and Agile sprints address bug fixes and enhancements, applying DevOps principles for future changes. This integrated approach ensures efficient development, deployment, and continual project enhancement.

- **Dataset Collection and Preprocessing:** The success of the project is closely tied to the quality and diversity of datasets utilized. In the case of the depression detection application, the availability of natural language query datasets plays a pivotal role in training and improving the NLP (Natural Language Processing) models. Additionally, for the depression detection system, Kaggle.com has been identified as a valuable source for obtaining pertinent review datasets. These datasets encompass a wide range of data, including sentiment analysis and medical health-related information, and are of utmost importance for effectively training the depression detection model. Additionally, to fortify the system's support network, a database of psychiatric doctors is being compiled from publicly accessible internet sources like the Directorate of Mental Health's official website. The collected data undergoes thorough preprocessing. This involves text cleaning, removal of irrelevant information, and standardization of text formats. Additionally, the data is labeled with depression severity scores, enabling supervised learning for model development.

## 3. Functional Features

- **Registration of Users**: Users can register as patients, guardians, or physicians, providing basic information like name, age, email address, and phone number. Additional data collection depends on the user type (patient, guardian, or doctor).

- **User Authentication:** The system ensures secure login using email and password for user privacy.

- **User Profiles:** Patients create profiles with relevant health information, guardians offer contact details for those they are responsible for, and doctors include professional information and specialties.

- **Mood Assessment:** "EmoAssist" employs natural language processing (NLP) and speech analysis to assess users' moods and emotional states during conversations.

- **Detecting Depression:** The AI-driven system accurately detects signs of depression, anxiety, or stress based on user input and mood assessments.
- **User Interaction:** Users can engage in voice-based conversations with the chatbot to discuss their mental health concerns, and the chatbot uses NLP to facilitate meaningful interactions.
- **User Support and Guidance:** The system provides immediate support and guidance to users based on their mental health assessment, offering advice, self-help strategies, or recommendations for further professional help.
- **Data Privacy and Security:** Strong data encryption and access controls are implemented to safeguard sensitive mental health data, ensuring compliance with data protection regulations like GDPR and PDPR, with regular security audits and monitoring.
- **Connection to Professionals:** Users can connect to mental health professionals for consultations or appointments through integration with external API services, including appointment scheduling.
- **User-Friendly Interface:** The platform offers an intuitive and user-friendly interface for seamless interaction, accessible through both a website and a mobile application.
- **Real-time Notifications:** Users receive real-time notifications and alerts, including automated messages to guardians in case of severe conditions.
- **Continuous Improvement:** User feedback and data analysis inform ongoing system improvements, with regular fine-tuning of the AI model based on user interactions.
- **Cloud Deployment:** The system is hosted on a secure cloud server to ensure reliability and scalability.
- **Integration with External Services:** Integration with external APIs, such as doctor appointment scheduling services, enhances the user experience by providing additional functionalities.

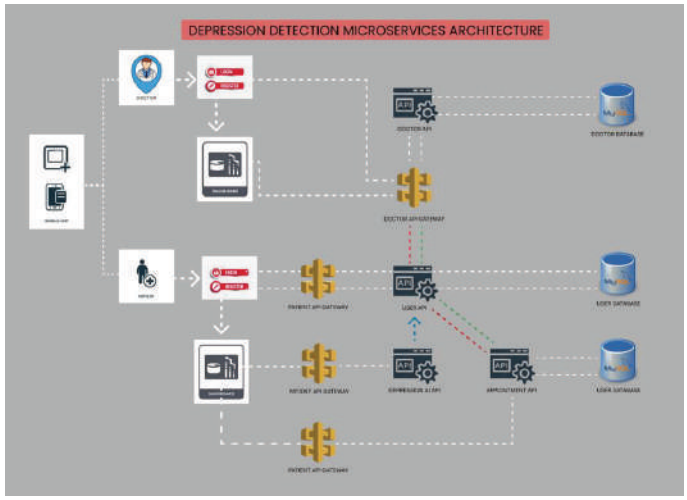


Fig. 1: Depression Detection Microservice Architecture

## 4. Depression Detection Model

**Language Processing (NLP) Techniques:** NLP techniques, facilitated by state-of-the-art libraries and frameworks like spaCy and NLTK, play a pivotal role in feature extraction from text data. This encompasses text tokenization, sentiment analysis, and feature extraction, enabling us to derive meaningful features such as sentiment scores, linguistic patterns, and semantic information.

**Machine Learning Model Selection:** The choice of a machine learning model is a critical decision in developing an accurate depression detection system. Several classification algorithms are evaluated, including logistic regression, support vector machines (SVM), and deep learning models such as recurrent neural networks (RNN) and convolutional neural networks (CNN). Rigorous experimentation and cross-validation are conducted to identify the most suitable model architecture for the task.

**Model Training and Evaluation:** The selected machine learning model undergoes extensive training on the preprocessed dataset. During training, techniques to address class imbalance issues and optimize model hyperparameters are employed. The model's performance is assessed using standard metrics, including accuracy, precision, recall, and F1-score, through k-fold cross-validation to ensure robustness and generalizability.

## 5. Results and Discussions

In this section, we delve into the results and discussion related to our "EmoAssist" project, encompassing user insights and preferences, as well as the development of the depression detection model.

- **User Insights and Preferences:** The research aimed to uncover critical user preferences and expectations regarding mental health support systems, especially within the Sri Lankan context. We gathered insights from 100 participants of diverse backgrounds and age groups.

- **Preferred Communication Channels:** A significant finding revealed a preference for digital communication channels, with approximately 78% of respondents favoring mobile applications or websites as means to access mental health support. This underscores the growing acceptance of technology in addressing mental health concerns.

- **Importance of Anonymity and Privacy:** Privacy and anonymity emerged as paramount concerns for users seeking mental health support. Over 85% of participants stressed the need for a secure and confidential environment when discussing their emotional well-being. This underscores the significance of robust data security measures in platforms like "EmoAssist."

- **Desire for Personalization:** Respondents expressed a strong desire for personalized support, with around 72% indicating an appreciation for a system that tailors its responses and recommendations based on their unique emotional needs and preferences. This highlights the potential of machine learning algorithms in "EmoAssist" to provide a more customized user experience.

### 5.1. Discussion

The results of the user surveys illuminate key considerations for the advancement of the "EmoAssist" platform. The preference for digital communication channels underscores a willingness to embrace technology for mental health support, emphasizing the importance of user-friendly interfaces. Additionally, the strong emphasis on privacy and anonymity aligns with the commitment to robust data security, essential for user trust. Furthermore, the desire for personalization highlights the potential of AI and NLP technologies to offer tailored emotional support. In conclusion, these user insights and preferences serve as guiding principles for ongoing development, aiming to create a user-centric mental health platform that promotes trust and contributes to enhanced mental well-being in Sri Lanka.

## 6. Conclusions

The chosen research approaches give the "EmoAssist" project a solid basis, covering quantitative data collecting and an organized development strategy. The platform's functional features, from mood assessment to user-friendly interfaces, are designed to meet user preferences, emphasizing the importance of digital channels, privacy, and personalization. The depression detection model's development, incorporating NLP techniques and machine learning model selection, ensures the platform's accuracy and effectiveness. User insights reveal a readiness to embrace technology for mental health support, highlighting the significance of these features. In conclusion, these methodologies and user-driven insights guide the creation of a user-centric "EmoAssist" platform, contributing to enhanced mental well-being in Sri Lanka.

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# EduBrain: The Smart Learning Hub

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## Abstract

Our research introduces an AI-Powered Student-Centric Learning Management System (AI-SCLMS) designed to provide personalized learning experiences and data-driven insights to instructors, addressing the challenges of traditional learning management systems. The project focuses on personalized learning, AI-powered early warning systems, and ethical considerations within a comprehensive framework. We've made progress in implementing AI-driven content suggestions and predictive analytics while emphasizing inclusiveness and cross-platform compatibility. Project management techniques, risk assessment, and milestones are crucial to ensuring success. The project's future involves continued development, testing, security measures, and user-driven enhancements, all with a focus on ethical considerations and educational outcomes.

## Extended Abstract

### 1. Introduction

Education is undergoing a profound transformation, driven by advancements in technology and the evolving needs of learners in the digital age. Traditional learning management systems are facing challenges in adapting to the diverse requirements of students, prompting the need for innovative solutions. In response, our research endeavors to tackle these challenges by introducing an AI-Powered Student- Centric Learning Management System (AI-SCLMS). This cutting-edge system harnesses the power of artificial intelligence and data science to deliver highly personalized learning experiences and equip instructors with data-driven insights. Our research focuses on key questions surrounding personalized learning, AI-driven early warning systems, and ethical considerations in educational technology, all within a meticulously designed developmental and evaluative framework. The AI-SCLMS project aspires to revolutionize the field of education by promoting interdisciplinary collaboration and a steadfast commitment to excellence.

## 2. Methodology

The research methodology adopted for this study is structured into a sequential process involving comprehensive data collection, stringent validation and testing, efficient data organization and analysis, and meticulous reporting. The methodology initiates with an extensive literature review delving into AI applications in education, focusing on personalized learning and learning management systems. The data collection process prioritizes compliance with stringent data privacy regulations while gathering a variety of information, including student profiles and feedback.

Extensive usability, performance, and functionality testing procedures are implemented to ensure the robustness and quality of the platform under investigation. The subsequent phase involves the validation of predictive analytics models intended for application within the educational setting. Emphasis is placed on efficient data management techniques and sophisticated analytical methods to derive meaningful insights from the collected data.

The research findings are effectively summarized and documented in research reports, presenting platform performance evaluations, insights derived from predictive analytics, and relevant user feedback. Throughout the entire research process, ethical considerations and concerns are seamlessly integrated, ensuring ethical standards are upheld at every stage of the project. This methodology guarantees a systematic approach to investigate the applications of AI in education, ensuring not only the reliability of the findings but also the ethical integrity of the research process.

## 3. Results and Discussion

Descriptive Analysis

Descriptive analyses are used in this study to describe the basic characteristics of the data. The descriptive analysis summarizes and quantifies the sample's demographic variables. They serve as the foundation for almost all quantitative data analysis, as well as simple graphics analysis. Respondents were asked to provide demographic information such as gender, level of education, and work experience.

User Type

Students make up 66% of the user base. Educators account for 16.7% of users. Administrators also constitute 16.7% of the user population.

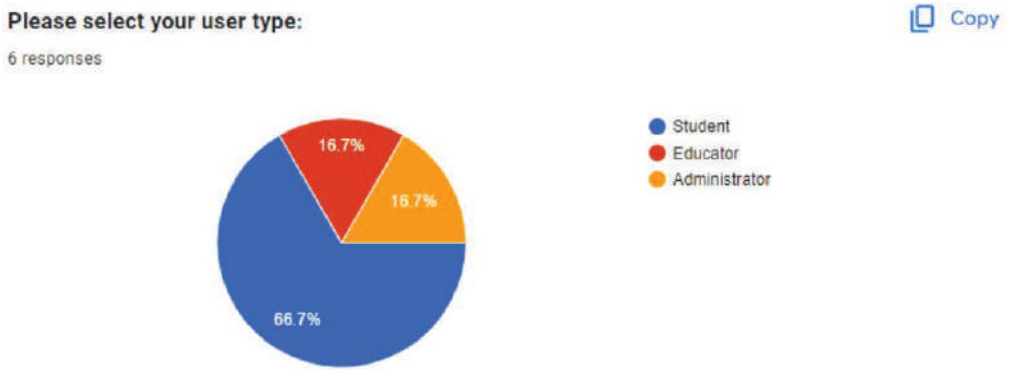


Figure 1: user type of Respondent

Level of Education of the Respondent

In a recent survey conducted among users of the EduBrain platform, 83.3% of respondents found personalized learning to be very helpful, while 16.7% indicated that it was helpful. These results highlight a strong positive perception of personalized learning among our user base.

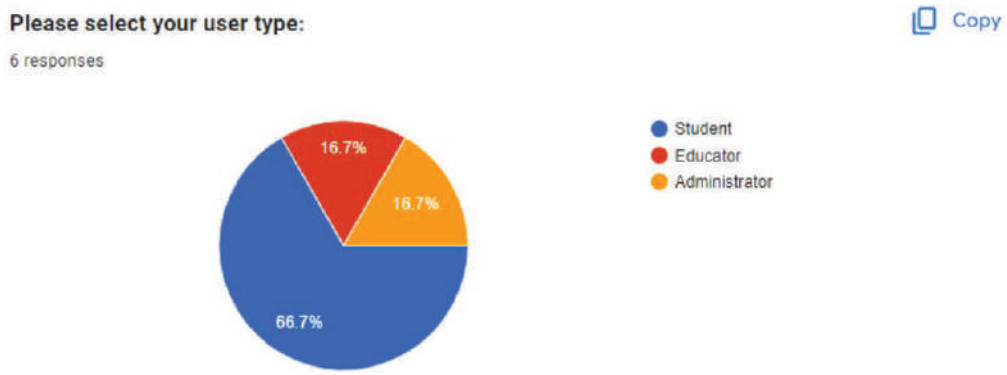


Figure 2: level of education

## 4. Conclusions

In this research, we have embarked on a journey to develop and evaluate an AI-Powered Student-Centric Learning Management System (AI-SCLMS), recognizing the transformative potential of artificial intelligence in education. Our comprehensive methodology, comprising data collection, validation and testing, data analysis, and reporting, has guided us towards our research objectives and the advancement of educational technology.

The literature review has revealed the significance of AI in education, the promise of personalized learning, and the evolving landscape of learning management systems. This foundational knowledge has shaped the development of the AI-SCLMS, ensuring it aligns with best practices and the latest trends.

Our data collection efforts, including user data and feedback mechanisms, have provided real-world insights essential to creating a platform that is responsive to the needs and preferences of its users. Usability, performance, and functionality testing have refined the platform, making it more user-friendly, reliable, and feature-rich.

The validation of predictive analytics models has demonstrated the potential of early warning systems to support students at risk. Data analysis techniques have extracted valuable insights from user data and feedback, guiding our decision-making process and continuous improvements.

Comparative analysis has shown the impact of the AI-SCLMS on student performance and engagement, reaffirming the platform's effectiveness. Robust documentation and reporting have ensured transparency and knowledge dissemination, benefiting the educational community and beyond.

Moreover, our unwavering commitment to ethical considerations, including data privacy and bias mitigation, underscores the responsible and inclusive development of AI in education.

As we conclude, our research project stands at the threshold of implementation and eventual release. The AI-SCLMS has already achieved significant milestones, such as AI-driven content recommendations and predictive analytics. These advancements are poised to redefine the educational experience, enhancing engagement, achievement, and inclusivity.

Our project management approach, diligent risk assessment, and contingency planning have safeguarded our progress, ensuring that potential challenges are addressed proactively. Milestones have been carefully selected to guide our efforts as we work towards project completion.

Looking ahead, we remain dedicated to our vision of improving learning experiences through innovative AI technologies. We will continue to listen to user feedback and prioritize ethical considerations, ensuring that the AI-SCLMS makes a meaningful and positive impact in the educational landscape.

In conclusion, the AI-SCLMS project represents a collaborative and multidisciplinary effort to advance educational technology. The fusion of AI, personalized learning, and ethical principles positions us to shape a future of learning that is adaptive, inclusive, and driven by data-driven insights. Our commitment to excellence and innovation in education is unwavering, and we look forward to the next stages of implementation with enthusiasm and determination.

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# MLIBRARIAN: Bridging the Global Education Gap with Cutting-Edge Technologies for Student Well-Being.

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## Abstract

In an era characterized by unprecedented technological advancements, emerging technologies have become the vanguards of progress and well-being on a student scale. This research paper explores the transformative potential of BCAS MLibrarian: an innovative web-based library management system integrating machine learning, as it addresses the critical challenge of fostering student well-being through enhanced access to knowledge and education.

Education, being a cornerstone of human development, plays an indispensable role in advancing well-being worldwide. However, disparities in educational resources and infrastructure persist across the globe, particularly in regions such as Sri Lanka. The BCAS MLibrarian project emerges as a beacon of hope in this context, harnessing the power of emerging technologies to revolutionize library services and, in turn, elevate well-being.

At its core, this project leverages machine learning algorithms to offer personalized book recommendations, transcending traditional library systems. By tailoring reading materials to individual preferences, BCAS MLibrarian engages students in meaningful learning experiences, instilling a love for reading and expanding intellectual horizons. This personalized approach not only addresses local challenges such as the scarcity of well-equipped libraries and trained librarians but also resonates with the student imperative of nurturing inquisitive, well-rounded individuals.

The integration of BCAS MLibrarian within the broader educational landscape holds profound implications for student well-being. It enhances the reputation of educational institutions like BCAS (British College of Applied Studies) in Sri Lanka, positioning them as pioneers of technology-driven, student-centric learning environments. This innovation-driven approach attracts prospective students seeking institutions committed to academic excellence and technological advancements, thereby fostering a competitive educational ecosystem.

Furthermore, this paper delves into the technical underpinnings of BCAS MLibrarian, showcasing the real-world impact and significance of this project. By examining data and case studies, we highlight the potential of emerging technologies to transform libraries into dynamic, inclusive spaces for information, creativity, and lifelong learning. The BCAS MLibrarian project exemplifies the fusion of emerging technologies and educational enrichment as a powerful catalyst for student well-being.

**Keywords:** Machine Learning (ML), Amazon Web Services (AWS), MongoDB, Library Management System, React JS, Tensorflow JS, Node JS, BCAS,

## Extended Abstract

### 1. Introduction

In an era where emerging technologies have become the catalysts for global progress and well-being, our research endeavors take us on an exploration of a transformative endeavor — BCAS MLibrarian against the backdrop of an ever-evolving digital landscape, libraries have long stood as bastions of knowledge, nurturing intellectual growth and academic excellence. Yet, within the intricate tapestry of student educational systems, we encounter disparities in access to these invaluable resources that threaten the well-being of students and communities.

Sri Lanka, a nation with a burgeoning educational ecosystem, provides a compelling case study. ***According to the University Grants Commission (UGC) report***, Sri Lanka boasts 22 state universities and 36 private institutes, all of which endeavor to provide library services to their students. (University Grants Commission, 2022)

| Province | University Libraries | School Libraries | | Public Libraries | Pirivenas Libraries | Collage of Education Libraries | Teacher Training College Libraries | Technical College Libraries | Colleges of Technology | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Formal | Temporary | | | | | | | |
| Western Province | 21 | 761 | 372 | 170 | 149 | 06 | - | 04 | 01 | 1484 |
| Central Province | 08 | 418 | 489 | 192 | 108 | 03 | 03 | 04 | 01 | 1226 |
| Southern Province | 05 | 590 | 313 | 154 | 161 | 02 | 02 | 04 | 01 | 1232 |
| Northern Province | 08 | 240 | 168 | 110 | 02 | 02 | 01 | 02 | 01 | 534 |
| Eastern Province | 05 | 312 | 262 | 167 | 23 | 02 | 02 | 05 | 01 | 779 |
| North Western Province | 02 | 491 | 333 | 174 | 97 | 01 | - | 03 | 01 | 1102 |
| North Central Province | 05 | 301 | 260 | 56 | 57 | 01 | - | 01 | 01 | 682 |
| Uva Province | 01 | 327 | 215 | 69 | 64 | 01 | - | 04 | 01 | 682 |
| Sabaragamuwa Province | 03 | 419 | 326 | 84 | 90 | 01 | - | 03 | 01 | 927 |
| Total | 58 | 3,859 | 2,738 | 1,176 | 751 | 19 | 08 | 30 | 09 | 8,648 |

*Figure 1 Source: UGC/ School Census Report / Statistical Abstract /Central Bank Report - 2022*

This commendable commitment to equitable access to resources, however, veils a stark reality — a chasm in library infrastructure and resources across these institutions. Inadequate facilities, outdated technologies, and constrained budgets compromise the delivery of an optimal library experience. The absence of adequate funding impedes the acquisition of new books, digital resources, and cutting-edge technologies, thus constraining libraries' ability to meet the diverse and evolving needs of students.

The urgency of addressing these challenges is underscored by data sourced from a **recent user survey conducted at the University Library of Sri Lanka**, presented by the **Sri Lanka Library Association**. (Statistics Branch of Ministry of Education of Sri Lanka, 2022)

| Library Facility | Number | Mean | Std. deviation | Minimum | Maximum |
|---|---|---|---|---|---|
| Reading Materials | 773 | 3.94 | 1.551 | 1 | 5 |
| Lightning | 702 | 4.13 | 1.408 | 1 | 5 |
| Photocopy service | 759 | 3.49 | 1.740 | 1 | 5 |
| Computers | 722 | 3.30 | 1.748 | 1 | 5 |
| Library catalogs | 695 | 3.78 | 1.660 | 1 | 5 |
| Seating capacity | 682 | 4.12 | 1.425 | 1 | 5 |
| Cleanliness | 701 | 4.26 | 1.290 | 1 | 5 |
| Staff | 736 | 4.11 | 1.415 | 1 | 5 |
| Security | 729 | 3.95 | 1.540 | 1 | 5 |
| Opening Hours | 699 | 3.98 | 2.687 | 1 | 5 |

*Figure 2 Sri Lanka Library Association (SLLA) Report 2022 (User Satisfaction on Library Facility).*

| | Responses (N= 286) | Frequency |
|---|---|---|
| 1 | Library needs to: add new books and reference resources in various subjects disciplines, increase no. of journals and add more electronic databases | 129 |
| 2 | Library needs more computers with speed internet access for students' use | 59 |
| 3 | Library hours should be extended till 8.00 pm | 34 |
| 4 | Improve photocopy service by providing more machines to reduce long queues | 35 |
| 5 | Library needs to enhance its physical environment by providing more ventilation and noise control | 18 |
| 6 | Library needs to automate all library operations by using integrated library software package | 11 |
| | Total | 286 |

*Figure 3 Sri Lanka Library Association (SLLA) Report 2022 (Additional Comments or Suggestions).*

This survey illuminate's user satisfaction levels and serves as a clarion call for improvements in library facilities. Shockingly, many facets of Sri Lankan libraries have remained unchanged for years, signifying a pressing need for enhancements to align with evolving student and researcher needs.

Moreover, the dearth of trained librarians in Sri Lanka exacerbates these challenges. Trained librarians are the custodians of knowledge, guiding students in their research quests and nurturing information literacy skills. However, the **UGC report** emphasizes the scarcity of qualified librarians, leading to compromised library services and diminished support for students' information-seeking needs. This human resource shortage necessitates investments in professional development programs to cultivate a skilled workforce capable of driving library excellence. (Perera *et al.* 2009) (Gunasekera, 2010)

In tandem with these internal challenges, a ***2022 survey by the National Library and Documentation Services Board (NLDSB)*** unveils a disconcerting trend in Sri Lanka's reading culture. A **mere 38%** of Sri Lankan adults engage in reading for pleasure, with the majority reading solely for work or academic purposes. This revelation underscores the urgency of cultivating and promoting a vibrant reading culture, especially among young individuals. Encouraging students to read for pleasure not only enhances language skills, critical thinking, and creativity but also instills a lifelong love for learning and personal development. (NLDSB, 2016) (Statistics Branch of Ministry of Education of Sri Lanka, 2022)

The confluence of these multifaceted challenges serves as the impetus behind the BCAS MLibrarian project, a groundbreaking web-based library management system that leverages advanced technologies, particularly machine learning (ML). This project aims to revolutionize how educational institutions in Sri Lanka approach library services, thus aligning perfectly with the theme of "THE NEXT FRONTIER: Emerging Technologies for Global Well-being." Through the integration of ML algorithms into the MLibrarian system, personalized book recommendations are offered to users based on their unique reading histories and preferences. This personalized approach has the potential to captivate students' interest, introducing them to a diverse array of books, authors, and genres aligned with their individual tastes, thus fostering a culture of curiosity, exploration, and well-being. (Ranasinghe, 2008) (Gunasekera, 2010)

Furthermore, the BCAS MLibrarian project extends its implications beyond individual user benefits. The integration of machine learning technology within library management systems not only enhances educational institutions' reputation but also positions them as pioneers in academic excellence, student engagement, and technological advancements. In a competitive landscape, embracing modern, technology-driven approaches is paramount for educational institutions to attract prospective students seeking institutions at the forefront of educational innovation.

In the pages that follow, we delve into the technical intricacies, implementation strategies, and performance evaluation of the BCAS MLibrarian project. Real-world data and case studies are presented to highlight the project's impact and significance. Additionally, we explore the potential long-term implications of this innovative project on the educational landscape in Sri Lanka, emphasizing the transformative power of advanced technologies and personalized learning experiences. Through this meticulous examination, our aim is to underscore the significance of the BCAS MLibrarian project in reshaping library management, fostering a reading culture, and shaping the future of education in Sri Lanka, ultimately contributing to student well-being. (Perera *et al.* 2009)

## 2. Methodology

### *2.1 Data Collection and Dataset*

The foundation of this research project will lie in the acquisition of relevant data to construct and validate the machine learning model at the heart of the BCAS MLibrarian system. Data collection will be conducted in several phases to ensure comprehensive coverage of user preferences and reading histories.

Initially, user histories and preferences will be gathered from the University Library of Sri Lanka, where the BCAS MLibrarian system will be deployed. This dataset will serve as a foundational resource for training the machine learning model. Additionally, demographic information and borrowing patterns will be collected to facilitate personalized recommendations.

To supplement this initial dataset and ensure its generalizability, data from a diverse range of educational institutions across Sri Lanka will be acquired. Collaborations will be established with several state universities and private institutes to access their library records. These institutions will represent a cross-section of the educational landscape in Sri Lanka, varying in size, resources, and student demographics. The inclusion of data from these institutions aims to capture a broader spectrum of user behaviors and preferences.

### *2.2 Machine Learning Model*

The core of the BCAS MLibrarian project will be its machine learning model, which will be responsible for generating personalized book recommendations. The machine learning pipeline will comprise several key steps. (Kletz *et al.* 2019)

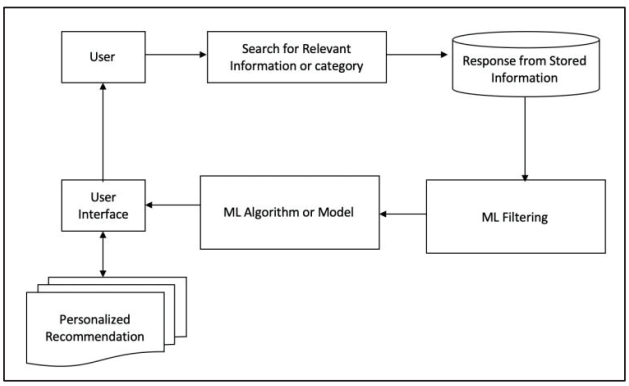


*Figure 4 Model Diagram.*

***2.2.1 Data Preprocessing:*** Prior to model training, data will undergo preprocessing, including data cleaning, normalization, and feature engineering. This step will aim to ensure data quality and compatibility with the chosen machine learning algorithms. (Gerard, 2020) (Sohn, 2020)

***2.2.2 Algorithm Selection:*** The choice of machine learning algorithms will be critical to the success of the recommendation system. Multiple algorithms, including collaborative filtering, content-based filtering, and hybrid approaches, will be considered and evaluated based on their performance metrics, including accuracy, precision, and recall. (Sheldon and Denman, 2022) (Kletz *et al.* 2019)

***2.2.3 Model Training:*** The machine learning model will be trained using a combination of historical user interaction data and book attributes. The dataset will be divided into training and validation sets to fine-tune the model's hyperparameters and prevent overfitting. (Kletz *et al.* 2019)

***2.2.4 Evaluation Metrics:*** Model performance will be assessed using standard evaluation metrics, including Mean Absolute Error (MAE), Root Mean Square Error (RMSE), and Area Under the Receiver Operating Characteristic Curve (AUC-ROC). These metrics will be chosen to measure the accuracy, precision, and recall of the recommendations. (Gerard, 2020)

### *2.3 Implementation and Deployment*

The BCAS MLibrarian system will be implemented using a modern tech stack, including the **MERN (MongoDB, Express.js, React, Node.js) stack** for web development, **Tensorflow.js** for machine learning, and **AWS (Amazon Web Services)** for hosting and scalability. The web-based platform will ensure accessibility for users across different devices and locations.

Deployment will involve integrating the machine learning model within the web application, allowing users to receive personalized book recommendations in real-time. The system will be rigorously tested to ensure its stability and responsiveness under various loads and user scenarios. (Anonymous, 2007) (AWS, 2023)

### *2.4 User Testing and Feedback*

User testing will be a crucial component of this research project. A sample of users from different educational institutions in Sri Lanka will be invited to interact with the BCAS MLibrarian system. Their feedback, including satisfaction levels, usability, and the relevance of recommendations, will be collected through surveys and user interviews. This qualitative data will be instrumental in refining the system and fine-tuning the machine learning model. (Testim, 2019) (Symphony, 2021)

### *2.5 Ethical Considerations*

Ethical considerations will play a paramount role throughout this research. Data privacy and user consent will be carefully addressed, and all data collected will adhere to stringent privacy regulations such as the Personal Data Protection Act (PDPA) No. 26 of 2019, Intellectual Property Act No. 36 of 2003, and Copyright Act No. 37 of 2003, ensuring legal compliance and adherence to local regulations. Users will be informed about data usage and provided with options to opt out of data collection.

This methodology section outlines the process of data collection, machine learning model development, system implementation, user testing, and ethical considerations that underpin the BCAS MLibrarian project. It reflects a rigorous and comprehensive approach to designing and deploying an advanced technology solution for library management and personalized book recommendations.

## 3. Results and Discussion

In the rapidly evolving landscape of educational technology and student well-being, understanding user preferences and expectations is paramount. The BCAS MLibrarian project aims to leverage emerging technologies, particularly machine learning, to enhance the library experience and foster a culture of reading and research. To achieve this, a comprehensive survey was conducted to gauge user sentiments and anticipate the potential impact of the project.

*Table 1 Demographic Characteristics of Survey Participants*

| Characteristic | Percentage (%) |
|---|---|
| Gender | |
| - Male | 63.0 |
| - Female | 29.0 |
| - Prefer not to disclose | 8.0 |
| Age Group | |
| - 18-24 years old | 76.0 |
| - 25-34 years old | 14.0 |
| - Under 18 years old | 10.0 |
| Connection to BCAS | |
| - Student/Faculty at BCAS | 76.0 |
| - No affiliation with BCAS | 24.0 |
| Field of Study | |
| - Information Technology | 59.0 |
| - Business Management | 14.0 |
| - Civil Engineering | 10.0 |
| - Other | 14.0 |

The demographic profile of survey participants reflects a diverse group, primarily composed of individuals aged 18-24 years, with the majority having connections to BCAS as students or faculty members. The predominant presence of Information Technology professionals emphasizes the relevance of emerging technologies in educational contexts.

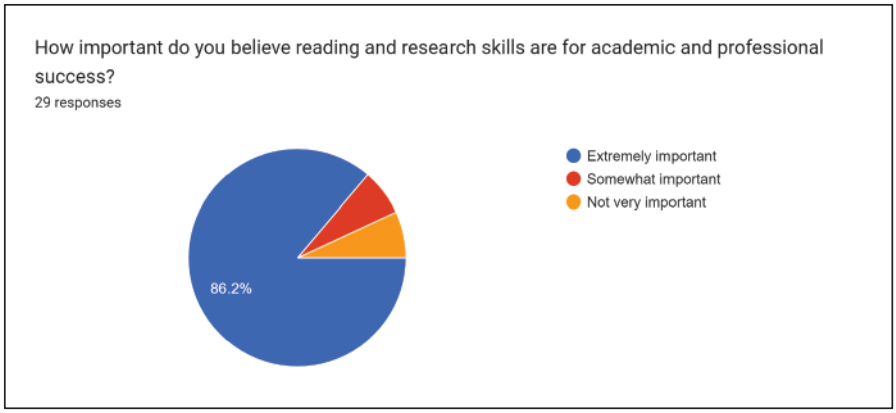


*Figure 5 Importance of Reading and Research Skills*

Survey respondents overwhelmingly recognize the significance of reading and research skills for academic and professional success. A striking 86% of participants believe these skills are of paramount importance. In the context of student well-being, these skills are vital for cultivating critical thinking, problem-solving abilities, and innovation.

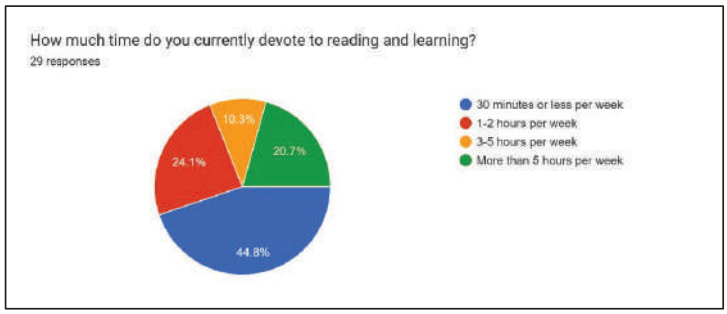


*Figure 6 Reading Habits and Preferences.*

While a diverse range of reading habits was observed, the survey reveals that a substantial portion (45%) dedicates up to 30 minutes per week to reading and learning. Understanding the reading habits of users is crucial for the BCAS MLibrarian project, as it seeks to encourage and facilitate reading for personal and academic growth.

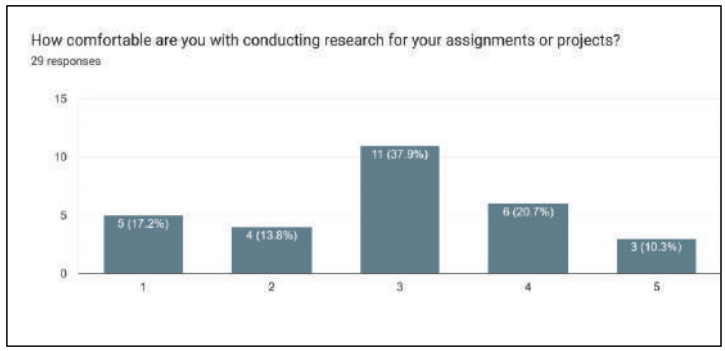


*Figure 7 Library Utilization and Challenges.*

The discomfort expressed by 77% of respondents in conducting research for assignments or projects highlights an area where technology-driven solutions can make a significant impact. Improving research skills and confidence can contribute to academic excellence and student well-being by promoting independent learning.

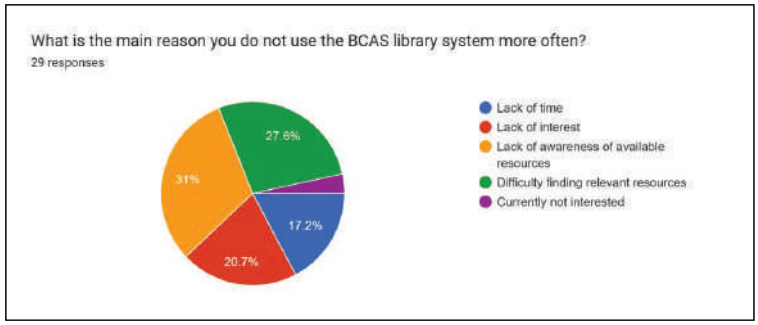


*Figure 8 Reason Behind not engaging with BCAS Library.*

The challenges faced in library utilization, such as a lack of awareness about resources and difficulties in locating materials, underscore the need for a user-friendly library management system. Enhancing library services can contribute to student well-being by making knowledge more accessible.

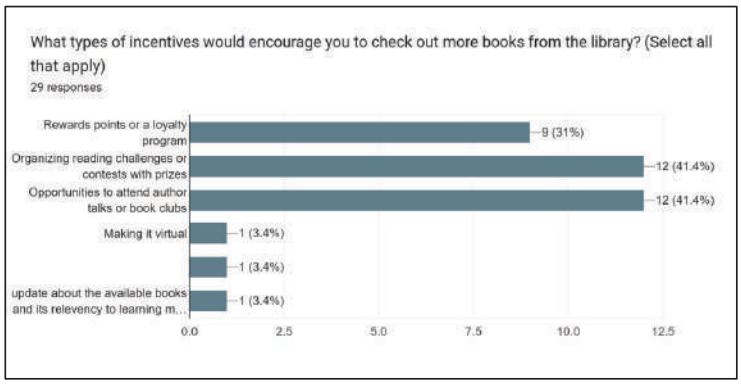


*Figure 9 Motivators for Borrowing Books.*

Understanding the incentives for borrowing books is vital for designing engaging library experiences. The interest in rewards, reading challenges, and author talks indicates that gamification and community-building can play a role in promoting reading culture and student well-being.

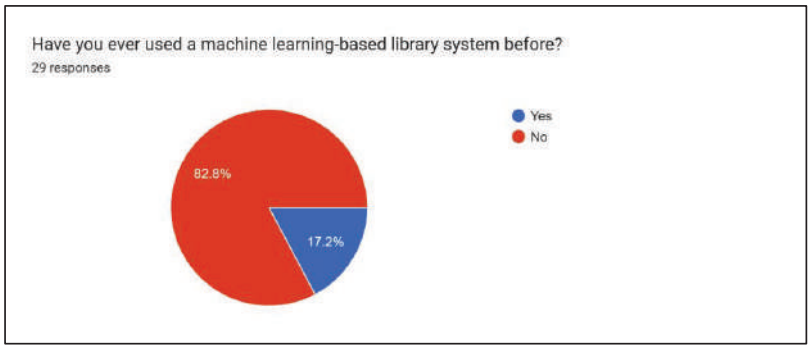


*Figure 10 Familiarity with Machine Learning in Libraries.*

The majority (84%) of respondents have not encountered library systems incorporating machine learning technology. This underscores the innovative potential of the BCAS MLibrarian project, which aims to introduce advanced technology to enhance library experiences.

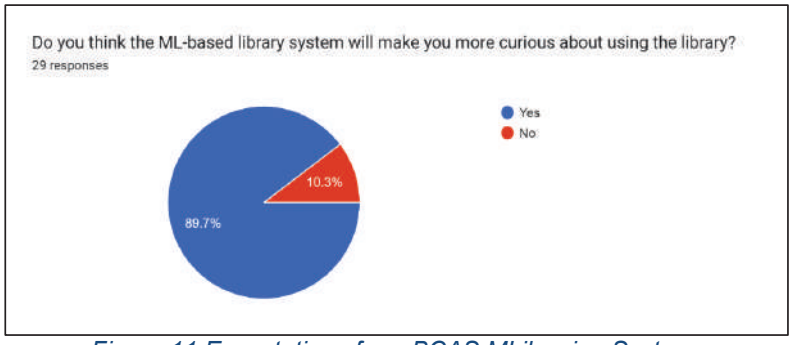


*Figure 11 Expectations from BCAS MLibrarian System.*

Anticipation for the BCAS MLibrarian system is high, with nearly 90% of respondents expecting an enhancement in curiosity and library utilization. These expectations fostering a culture of continuous learning and knowledge exploration.

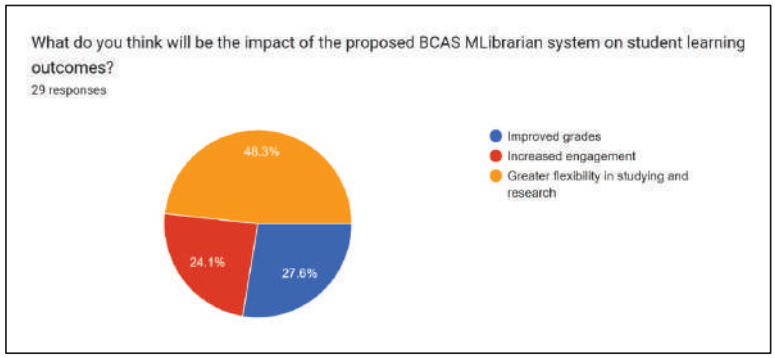


*Figure 12 Improvements in Studies, Research, and Grades.*

According to the survey results, most participants expressed their belief that the upcoming BCAS MLibrarian system would provide them with more flexibility in their studies and research. Additionally, a considerable portion of respondents expected to see improvements in their grades and higher levels of engagement with the system.

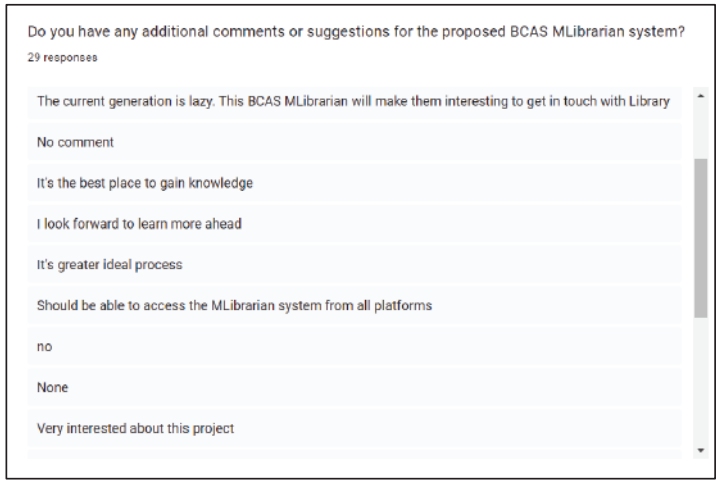


*Figure 13 Feedback and Suggestions.*

The next frontier involves active user involvement. Participants provided valuable feedback and suggestions, offering insights and potential improvements for the BCAS MLibrarian system.

The survey results illustrate the diverse backgrounds, preferences, and expectations of potential users, laying the foundation for the BCAS MLibrarian project's development and implementation. By addressing the identified challenges and aligning with user preferences, the project has the potential to foster student well-being through improved access to knowledge, enhanced research capabilities, and the promotion of a culture of reading and continuous learning.

## 4. Conclusions

The BCAS MLibrarian project, positioned at the intersection of advanced technology and educational enrichment, presents a promising trajectory towards the next frontier of student well-being. In a world characterized by rapid technological advancements, the quest for knowledge and information access has never been more critical. Our research, conducted against the backdrop of "THE NEXT FRONTIER: Emerging Technologies for student Well-Being," sought to understand the dynamics of library utilization, reading habits, and the expectations of users within the context of Sri Lankan educational institutions.

The survey findings unveiled a diverse landscape of readers and learners, emphasizing the multifaceted nature of their preferences, challenges, and aspirations. It became evident that a significant proportion of participants place great importance on reading and research skills, aligning with the overarching theme of student well-being. Furthermore, the results highlighted the prevalent challenges faced by students and researchers in navigating library resources, emphasizing the pressing need for technological interventions to enhance accessibility and user experience.

The introduction of machine learning into library management, as envisioned by the BCAS MLibrarian project, offers a transformative approach. Participants expressed their belief in the project's potential to provide them with more flexibility in their studies and research, anticipating improvements in grades and higher engagement with the system. This underscores the symbiotic relationship between technology, education, and the pursuit of knowledge.

Efficient communication preferences were also noted, reflecting the importance of seamless information dissemination in today's digital era. The survey respondents' strong anticipation for the BCAS MLibrarian system signifies not only the relevance of technology-driven solutions but also the expectations of a user-centric library ecosystem.

As we journey into the next frontier of emerging technologies, the BCAS MLibrarian project stands as a beacon of innovation, poised to revolutionize library management and foster a vibrant reading culture. Its potential to empower students, researchers, and educators with personalized recommendations and accessible resources aligns seamlessly with the student well-being agenda. Moreover, the project holds implications beyond individual user benefits, positioning BCAS as a pioneer in academic excellence and technological advancements.

In conclusion, the BCAS MLibrarian project serves as a testament to the power of technology in shaping the future of education. By addressing the challenges faced by library systems and nurturing a culture of curiosity and exploration, it not only enhances the academic journey of students but also contributes to the broader goals of student well-being through knowledge dissemination and intellectual enrichment.

The next frontier beckons, and with the BCAS MLibrarian project as a catalyst, the future of education and information access in Sri Lanka appears brighter and more promising than ever before.

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# SMART BUILDING OPERATION CONTROL SYSTEM

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*[2]British College of Applied Studies, Sri Lanka.*

## Abstract

In the modern era, building management has evolved through technological strides, ushering in smart and innovative practices. The integration of new technologies has enabled buildings to independently control security, lighting, and climate, while the concept of IoT-powered smart buildings takes this further. These interconnected systems, utilizing the Internet of Things, enable real-time monitoring via sensors, akin to a building's sensory network. This article delves into the mechanisms of these systems, focusing on data collection, safety, and comprehensibility. The potential of IoT is harnessed to conserve energy, cut costs, and enhance comfort. Illustrated by "The Edge," an Amsterdam office building, the article showcases how sensors collaborate to optimize conditions based on occupancy. Objectives encompass detailed data gathering, system security, and user-friendly displays, all backed by testing. Ethical, environmental, regulatory, and financial facets are explored. Ultimately, the article underscores how IoT is reshaping building management, yielding safer, efficient, and improved spaces for all.

**Extended Abstract**

## 1. Introduction

In today's world, managing buildings has changed a lot because of new technologies. These technologies make things more modern and cleverer. Buildings can now control things like security, lights, and temperature all by themselves. But there's an even smarter way called "smart buildings." These use the Internet of Things (IoT) to connect everything together. This means we can watch things like temperature and security in real-time using computers and phones.

Let's think about IoT smart building system. It's like having special sensors in a building to collect information from far away. These sensors are like the building's eyes and ears. They help us know what's happening. This report is all about these smart systems and what they can do. It's like using these sensors to understand what's going on. The report also talks about making sure everything is safe and easy to understand. It's like having signs that tell us what's happening in the building. The report explains how IoT works and how it helps us know about the building's surroundings. It also talks about using this information to save energy, spend less money, and make buildings more comfortable and safer.

**Consider the case of The Edge, an innovative office building in Amsterdam**. It's a great example of an IoT smart building system. The Edge uses thousands of sensors to keep track of things like light, temperature, and occupancy. These sensors work together like a team of detectives, collecting information and sending it to a central computer. This computer then makes decisions to keep the building comfortable and energy-efficient. For example, if a room is empty, the lights and heating automatically turn off to save energy. This system not only makes the building more efficient but also provides a better experience for the people inside.

The report has a few main goals. First, it wants to gather detailed information using sensors. It's like the sensors are little detectives that tell us what's happening in the building. Second, it wants to make sure the system is safe. It's like having a strong lock on a door so only the right people can use it. Third, it talks about making displays that are easy for people to understand. It's like having pictures that show us what's happening in the building. The report also looks at how batteries are taken care of in things like ships or electric cars. It even creates a special system that uses IoT. This system has a plan for how it will work, a drawing that shows how it's made, and a prototype with sensors and tools to communicate. The report then tests this prototype to make sure it works well, is safe, and does what it's supposed to do.

Additionally, the report thinks about important things like being fair, the environment, rules, business, and money. It checks how much it costs to make this system and when it becomes a good idea to invest in it. The report also cares about safety and what the rules say about all of this. Overall, the report shows how IoT can make smart buildings change how we manage them and make them better places for everyone.

### 3.Overview Diagram of Proposed IoT Smart Building Operation Control System.

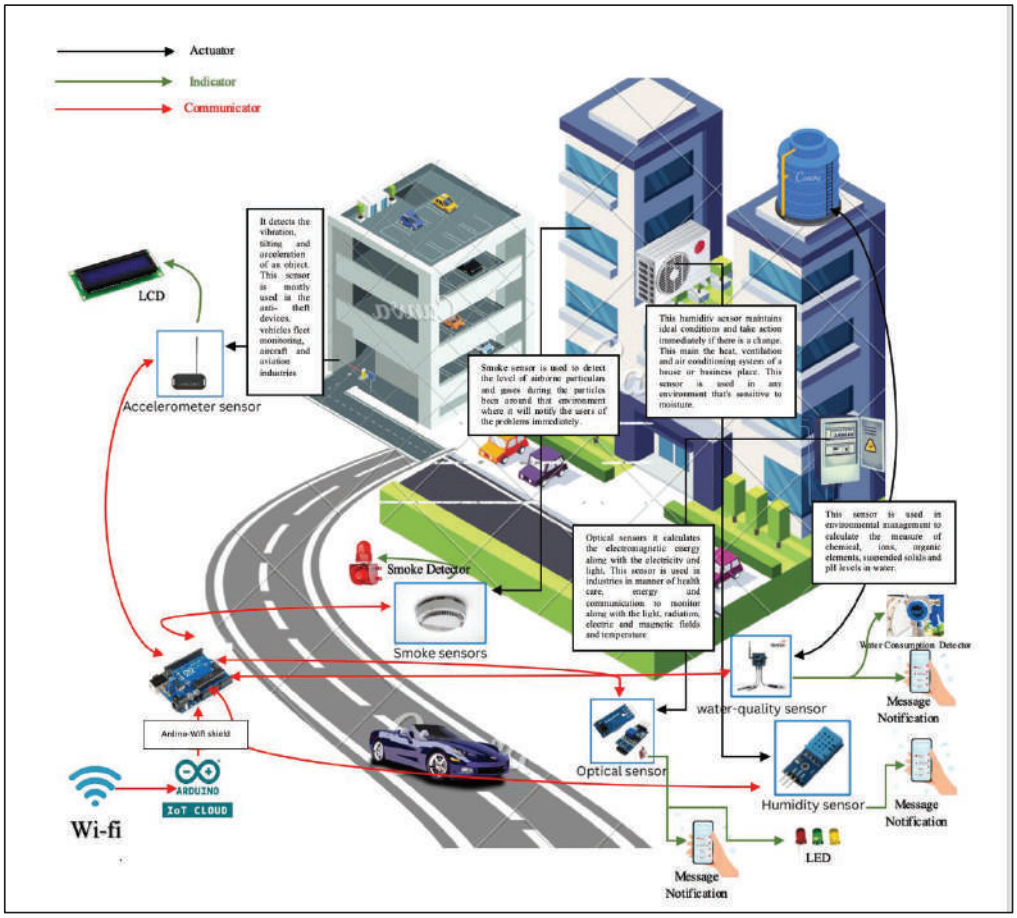



*Figure 1(Overview Diagram )*

This is an overview diagram of IOT Smart Building Operation Control System. Where I have implemented five sensors and for each sensor, I have connected the indicators These sensors connected with “Arduino Wi-Fi Shield”, This Arduino is connected “IOT Cloud’ and Wi-Fi.

## 4.Block Diagrams

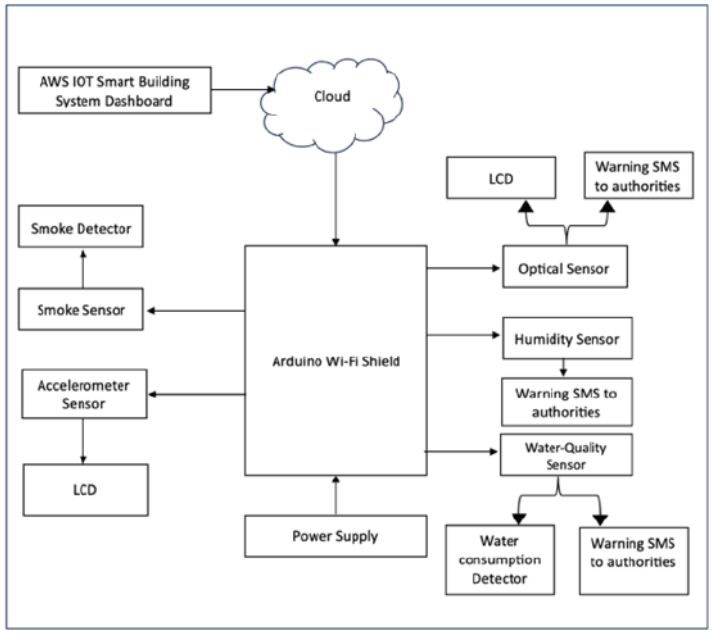



*Figure 2(Block Diagram)*

## 5 Ecosystem

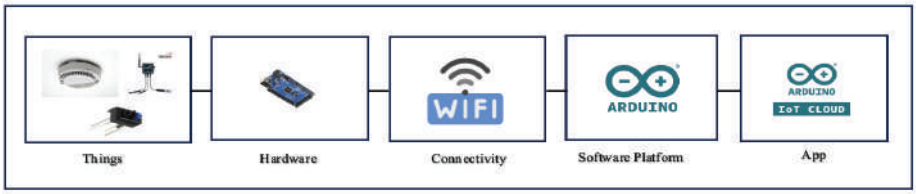



*Figure 3(Ecosystem)*

| Sensors | Gateway | Process Device | Application |
|---|---|---|---|
| **Smoke Sensor** | Wi-Fi | Arduino Wi-fi shield | Arduino IoT Cloud |
| **Optical Sensor** | | | |
| **Humidity Sensor** | | | |
| **Accelerometer Sensor** | | | |
| **Water-Quality Sensor** | | | |

*Table 1 (Sensor List )*

(Daissaoui et al,2020)

## 6.Methodology

The new way buildings are managed, called the Model Smart Building Operation Control System, changes how data is collected, sent, and understood. This has big benefits for making things work better and knowing more about what's happening.

- **Collecting Data:**
  Imagine special sensors that gather information like temperature and occupancy. These sensors work all the time, giving us real-time data. This is better than older ways of getting information manually. All this data helps us understand how the building works, which helps us make smarter choices.

- **Sending Data:**
  With smart devices and networks, data can be sent and received super quickly. This means we can check things in the building from far away. It helps with security and dealing with problems fast. If something goes wrong, we can act right away.

- **Understanding Data:**
  Because of real-time data, we can find out things we didn't know before. Smart programs can look at the data and tell us what to do. They can predict when things might break and how to save energy. This makes the building work better and saves money.

- **Making Smarter Choices:**
  Having real-time data and smart programs helps us make better decisions. People in charge of the building can save energy, make tenants more comfortable, and fix things on time. Smart programs also guess when problems might happen, so we can stop them before they get worse. These decisions, based on data, make the building work well, keep people happy, and save money.

- **Challenges and Things to Think About:**
  Even though this is great, there are challenges. We need to keep data safe from others. There's a lot of data, so we need strong systems to store and use it. Also, the data has to be right and good to use. The sensors and systems need regular care to keep working well.

The Model Smart Building Operation Control System uses smart technology to change how data is collected, sent, and understood. This makes building management much better, helping us make smart choices, saving energy, and making everyone happy.

(Daissaoui et al,2020)

## 7.Results and Discussion

### 7.1 .IOT Smart Building Operation System Artifact (Proto Type)

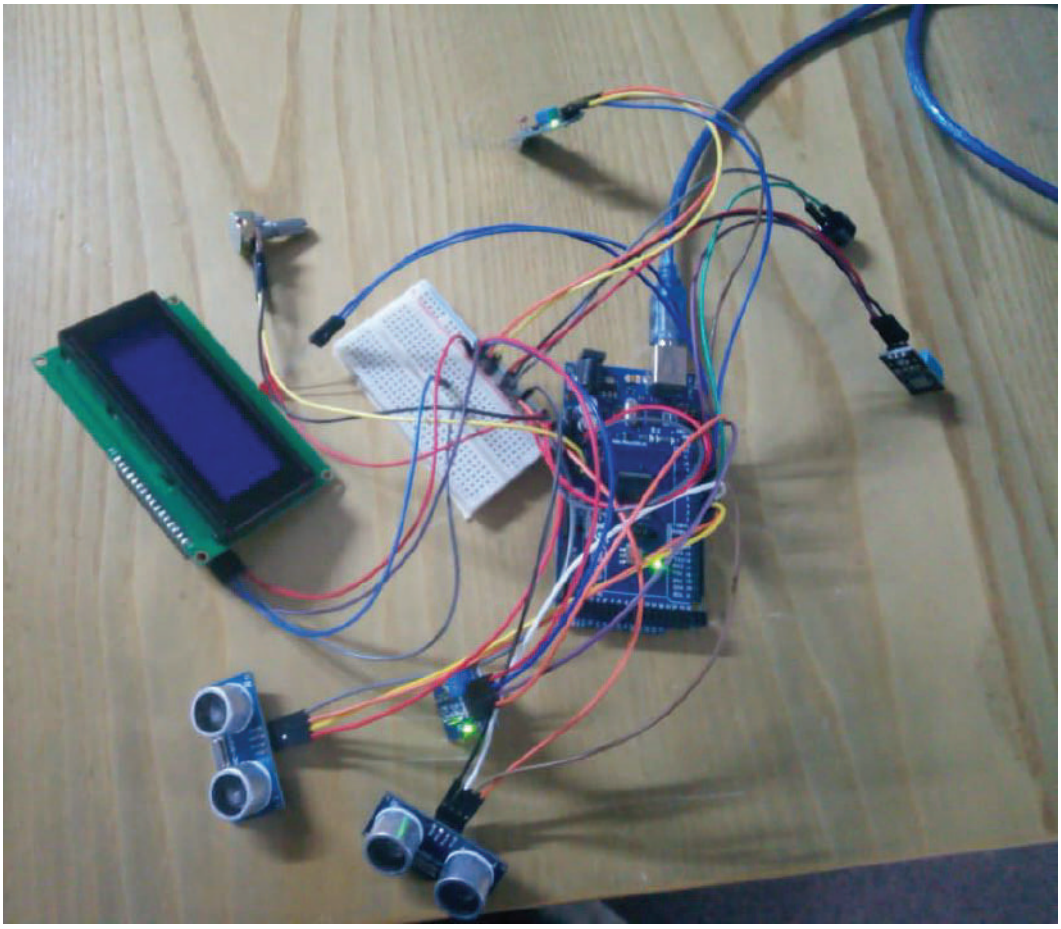


*Figure 4(Artifact)*

This is an artifact which designed in a way of demonstration of above over view diagram using the sensors, it's a proto type invention where we can do any upgrade in future if we need.

### 7.2 Arduino Cloud

*Figure 5(Arduino Cloud IoT)*

This the dashboard pf “Arduino Cloud “where all the sensors and implanted and tested successfully.

### 7.3 Model Implementation and Testing.

**Smoke sensor**

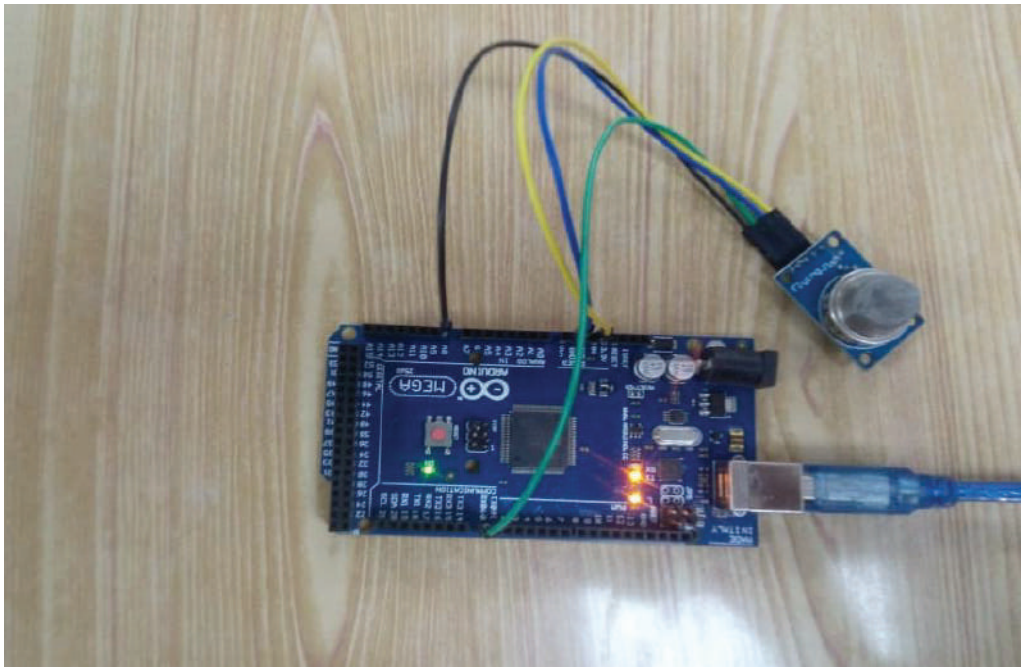
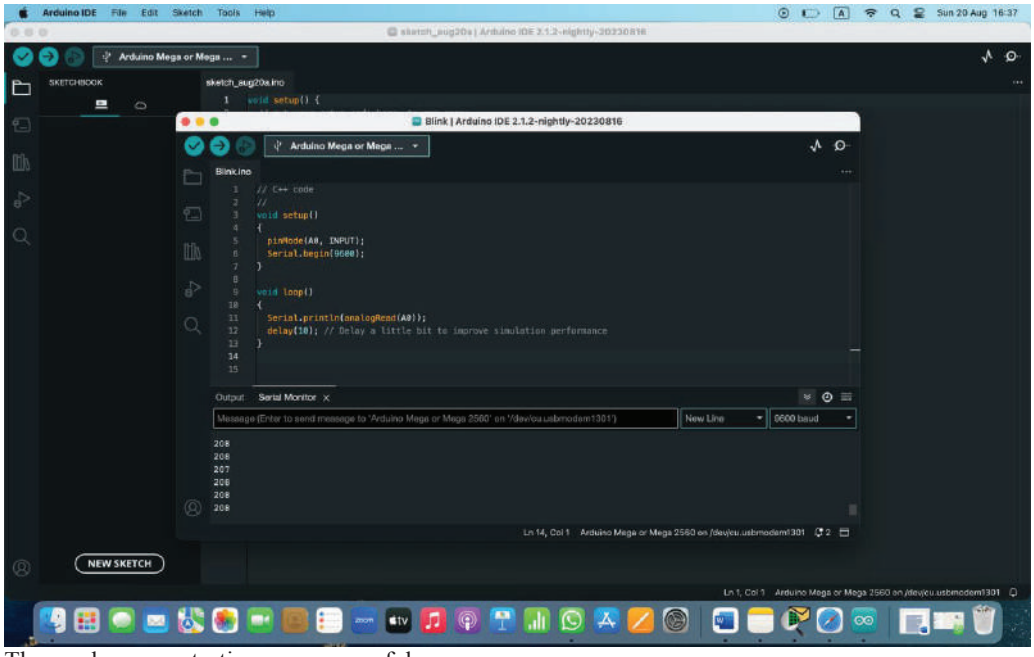


*Figure 6(Implementation of Smoke Sensor)*

This is the implementation of Smoke sensor.




The smoke sensor testing was successful.

*Figure 7(Testing of Smoke Sensor)*

### Optical sensor

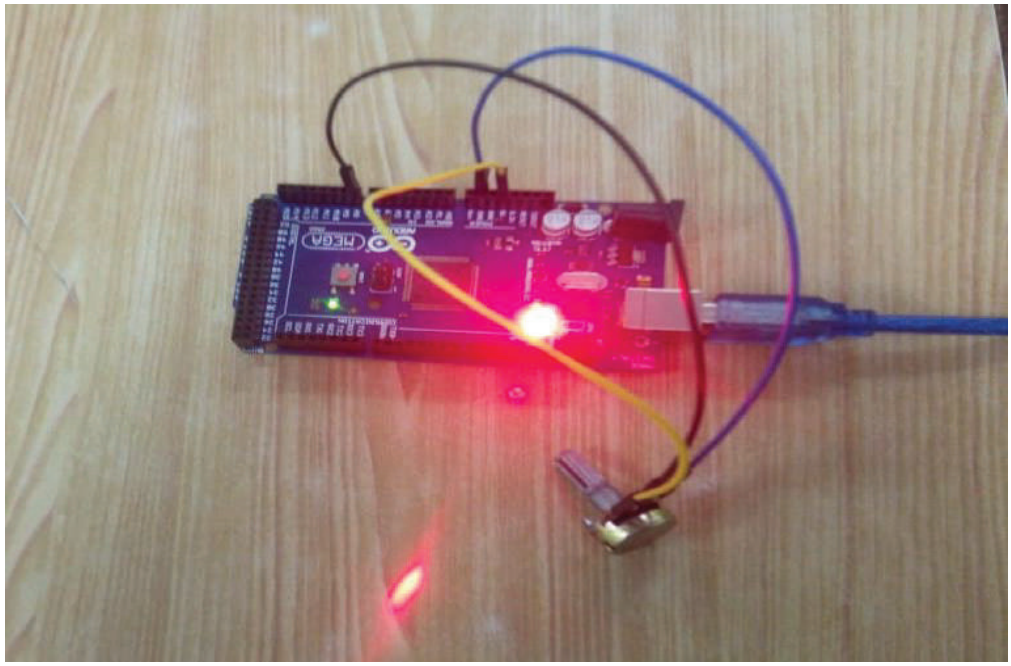


*Figure 8(Implementation of Optical Sensor)*

For implementation of Optical sensor .I used Patentor meter behalf of optical sensor.

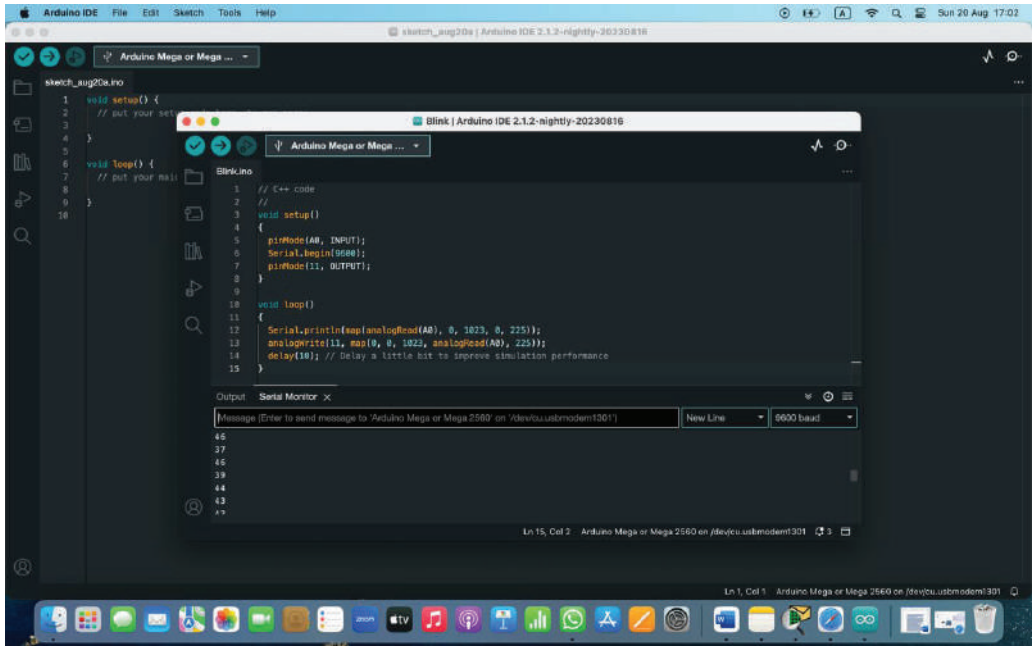



*Figure 9(Testing Of Optical Sensor)*

The testing is successful.

### 9.3 Humidity sensor

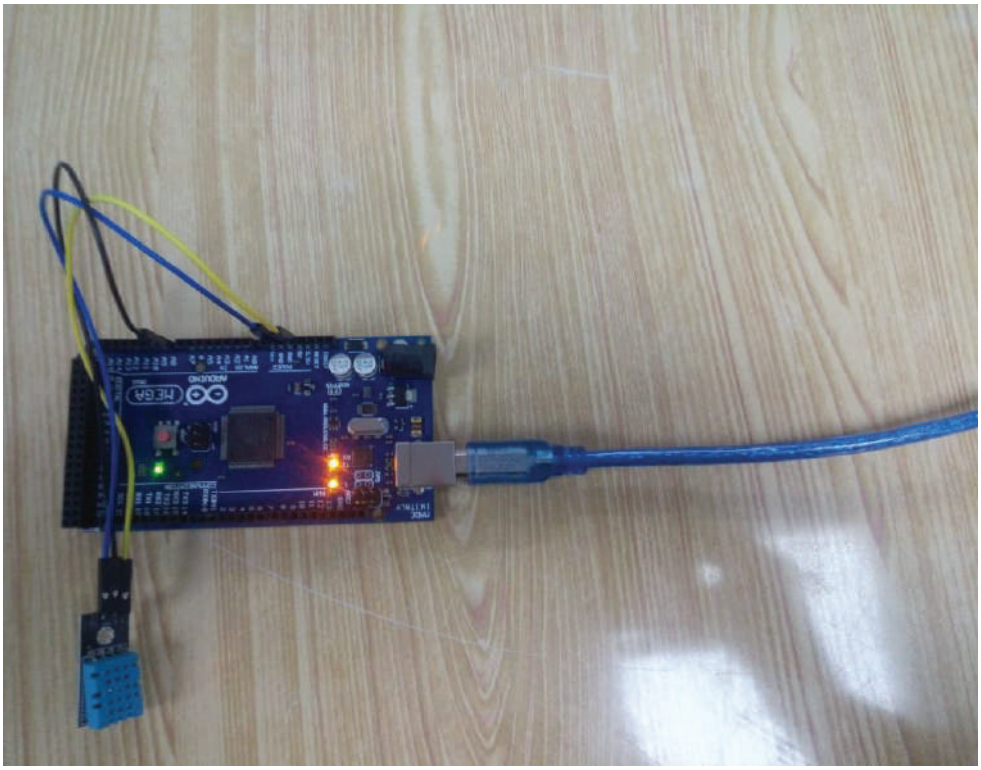
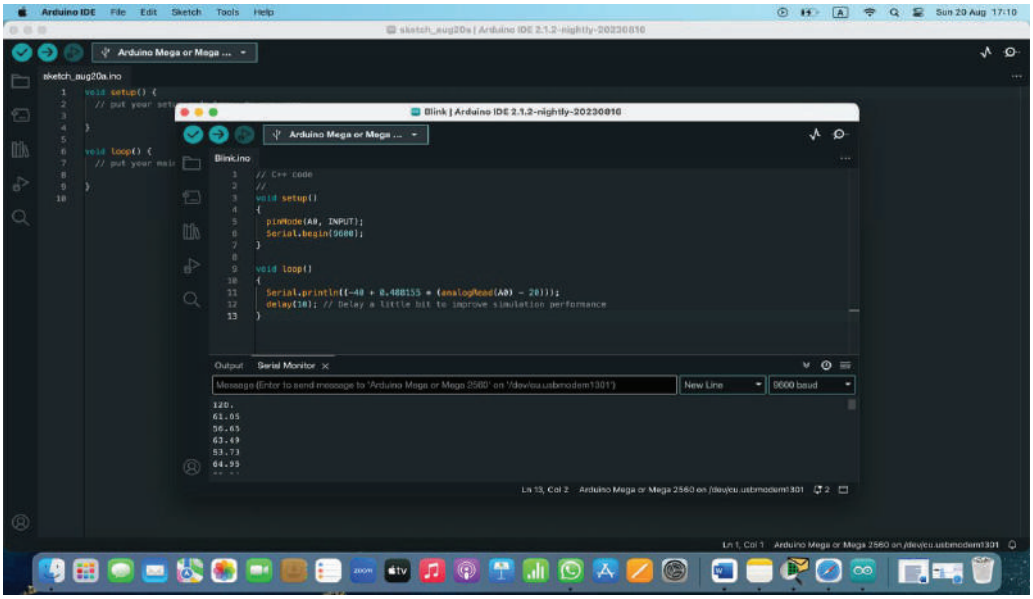


*Figure 10Implementation of Humidity Sensor)*

For implementation of humidity sensor. I used temperature sensor behalf of humidity sensor.




The testing is successful.

*Figure 11(Testing Of Humidity Sensor)*

**Accelerometer and water quality sensor**

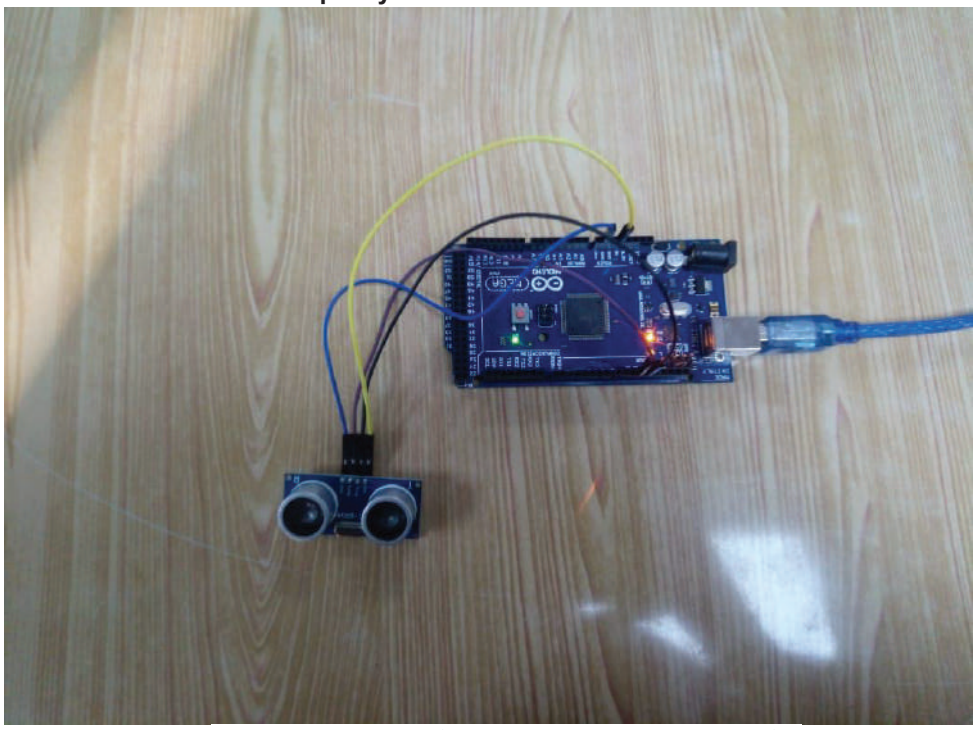
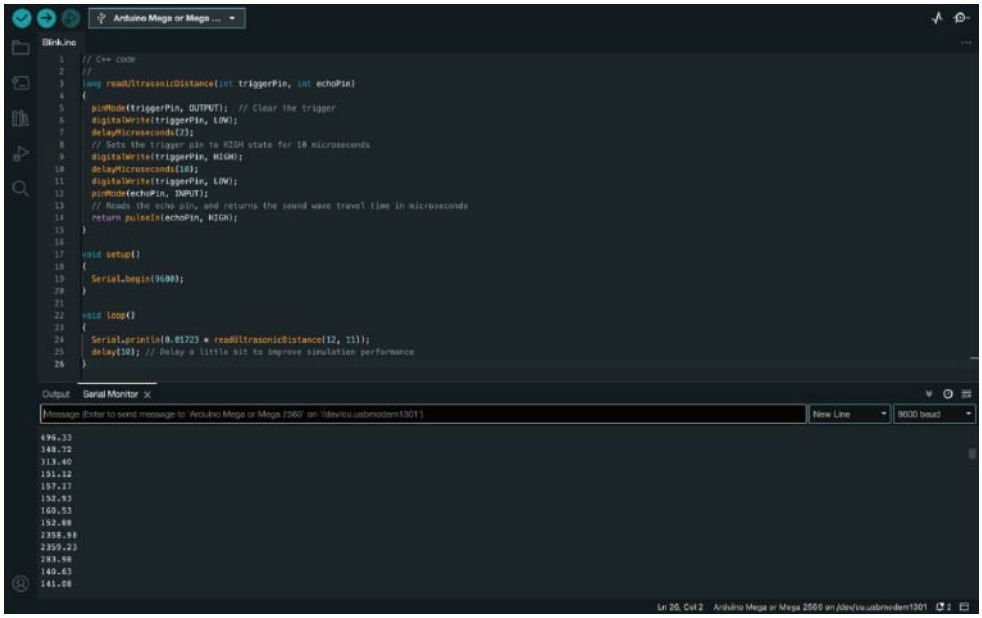


*Figure 12Implementation of Accelerometer & Water Quality Sensor)*

for implementation of Accelerometer and water quality sensor I used ultra sonic sensor behalf of Accelerometer and water quality sensor




The testing is successful *Figure 13(Testing of Accelerometer & Water Quality Sensor)*

**8.Model Evaluation**

The evaluation of my IoT smart building system underscores its remarkable advantages over traditional systems. The successful implementation of an integrated network of sensors, including smoke, humidity, optical, accelerometer, and water quality sensors, highlights the system's efficacy in ensuring building safety, comfort, and efficiency. The utilization of these sensors allows for real-time monitoring and immediate response to potential hazards, such as fires, changes in humidity levels, light optimization, structural integrity, and water quality. This surpasses the limitations of conventional systems, which often lack the precision and interconnectedness provided by IoT technology. The journey to achieve this success was not without challenges; navigating the complexities of sensor integration, data processing, and communication protocols posed significant obstacles. Nevertheless, the experience offered invaluable insights into the intricacies of IoT implementation, enhancing problem-solving skills and fostering a deeper understanding of technology. The ultimate triumph of the system in its successful demonstration underscores its practicality and potential to revolutionize building management by seamlessly merging cutting-edge technology with real-world applications.

(Zhang et al. 2019)

## Conclusions

In the contemporary era, technological advancements have reshaped building management, allowing for autonomous control and efficient operations. The concept of "smart buildings" driven by IoT connectivity has emerged, enabling real-time monitoring of various parameters such as security, temperature, and occupancy. This report delves into the world of IoT-powered smart building systems, shedding light on their benefits and potential.

The integration of IoT sensors within the framework of a building transforms it into a dynamic entity capable of responding to its environment in real time. The success story of The Edge in Amsterdam showcases the potential of a well-implemented IoT smart building system. By harnessing the power of IoT, this innovative office building ensures optimal energy utilization and provides an improved user experience.

While this transformation brings forth a new realm of possibilities, it also entails challenges. The integration of diverse sensors and communication protocols demands meticulous attention to ensure seamless operations. Maintenance and calibration of these sensors become pivotal for sustained accuracy and functionality, leading to operational longevity.

The journey toward successful IoT implementation has not been without hurdles. Overcoming intricacies of sensor integration, data processing, and communication protocols has fortified our understanding of this cutting-edge technology. The achievement of a functional system is a testament to its practicality and its potential to revolutionize building management.

The project underscores that IoT technology's merits far outweigh its limitations. The comprehensive array of sensors offers real-time monitoring, enhancing safety, efficiency, and resource management. Though challenges like integration complexities and costs exist, the system's demonstrable benefits make it a promising solution for modern building environments.

Looking ahead, the possibilities for advancing the system are exciting. By introducing specialized sensors for dangerous gases, occupancy, and noise levels, the system can further elevate its monitoring capabilities. This endeavour aligns with the project's ethos of continuous improvement. The lessons learned during the setup phase will guide future enhancements, driving advancements in the realm of building management.

In conclusion, the IoT-powered smart building system epitomizes the marriage of technological innovation and practical applications. Through this project, we have journeyed from concept to implementation, navigating challenges and discovering potentials. As we stride forward, the commitment to leveraging the latest technology for smarter, safer, and more efficient buildings remains unwavering, perpetuating the legacy of progress and innovation.

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# AGRI-TECH TRANSFORMATION -AGRICULTURES' DATA PROCESSING AUTOMATION WITH SERVELESS COMPUTING USING IoT, AWS AND DevOps

**Dhaniya Mowlana [*], Anis Saboorden[2]**

*[1]Solent University, United Kingdom.*
*[2]British College of Applied Studies, Sri Lanka.*

## Abstract

In a world with more and more people to feed, farming faces big problems. These include weird weather, using up natural resources, old-fashioned farming, and not knowing what will happen in the market. Even in Sri Lanka, where farming has always been important, these problems are felt. It's really serious when you see the facts. People say that by **2050**, there will be nearly **10 billion people on Earth**, and we'll **need to make 70% more food**. But Sri Lanka's farms are struggling too. For example, there's been less rice, a big food, and this isn't good for the country's economy and people's food.

Besides, COVID-19 and money troubles have caused issues for farms in Sri Lanka, even though lots of people work in farming. The problems include not growing enough food, sticking to old ways of farming, trouble from the changing climate, not having good information about markets, and not making the rules work well. To make things better, Sri Lanka's farming needs to use modern technology, improve education, and make it easier to sell food. This will help the country work towards big goals like making sure everyone has enough food and **isn't poor by 2030**.

In the face of all these big challenges, our project is here to help. We want to use special sensors that can connect to the internet to make farming easier. These sensors will do important tasks and give farmers helpful information about their fields in real-time. This will help them decide when to water, put fertilizer, and deal with pests. We'll also use a service called AWS to safely store and share the information from the sensors, so it can be used to farm smarter. We'll use special tools called DevOps to work better, faster, and with higher quality. But we won't do it alone. We want to work with other farmers and share what we learn to help even more people. This paper will explain how using these sensors, AWS, and DevOps can change farming in a good way, making it easier to farm and helping us reach a future where farming is better and our food is more secure.

**Extended Abstract**

## 1. Introduction

Agriculture, often referred to as the backbone of our world, has been facing terrifying challenges in recent years. As global populations continue to soar, food production must increase to meet the ever-growing demand. However, the agricultural sector conflicts with multifaceted issues ranging from climate change, knocking down natural resources, and inefficient practices to market unpredictability. Sri Lanka, despite its fertile landscapes and rich agricultural heritage, is not immune to these challenges.

The gravity of the situation becomes tangible when we examine real-world statistics. According to a recent report by the **Food and Agriculture Organization (FAO)**, the world's population is projected to reach **9.7 billion by 2050**. To sustain this population, food production must increase by a reeling **70%.** Meanwhile, Sri Lanka faces its own set of challenges, with news channels reporting a decline in crop yields due to erratic weather patterns and unacceptable resource management.

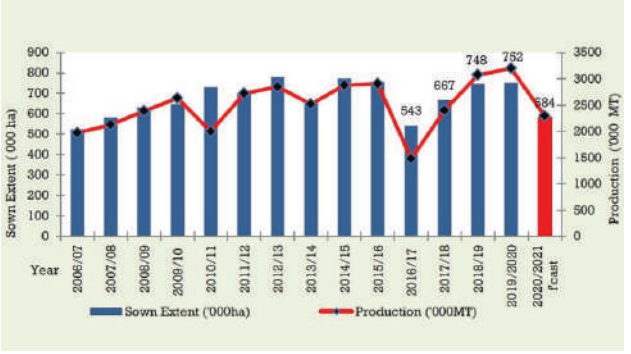



*Figure 1 Sri Lanka rough rice output in 2021 Maha could be down 10-pct*

This decline in crop yields in Sri Lanka is evident in the stark numbers reported by reputable news channels. For instance, a prominent article in **The Daily News** highlighted a significant drop in rice production over the past few years,

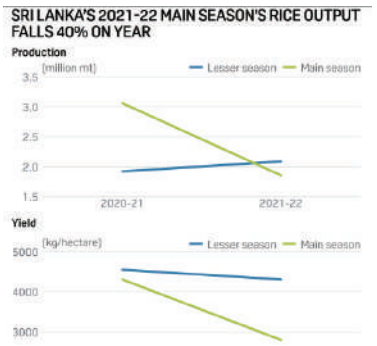



*Figure 2Source: Sri Lanka's Department of Census and Statistics*

a staple crop for the country. This decline in rice output not only affects the economy but also places added pressure on the already stretched food resources.

As well as the COVID-19 pandemic and economic crisis has disrupted global and Sri Lankan agriculture, impacting livelihoods and food supply chains. Agriculture, though its GDP contribution has dropped, remains a vital employer for over 25% of the workforce, predominantly in rural areas.

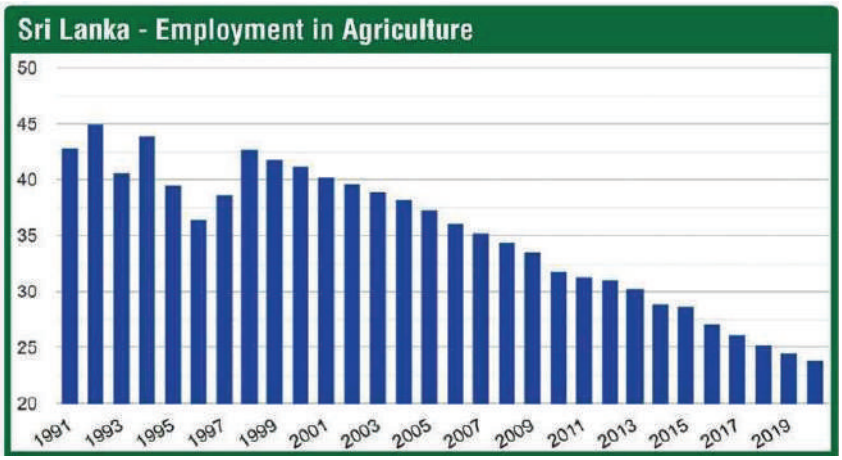



*Figure 3Sri Lanka - Employment Ratio in Agriculture past decades.*

Challenges include low productivity, dependence on traditional practices, climate change effects, lack of market information, and policy implementation issues. To thrive, Sri Lanka's agriculture needs technological modernization, improved education, market access, and strength -building against crises while striving to meet Sustainable Development Goals like zero hunger and poverty by 2030.

In the face of these discouraging challenges, our project seeks to introduce a holistic solution by integrating IoT sensors, we automate critical tasks and provide farmers with real-time field insights. This empowers them to make informed decisions on irrigation, fertilization, and pest control. AWS services play a pivotal role by securely storing and facilitating access to this data, enabling data-driven farming practices. DevOps tools optimize our processes, enhancing quality, efficiency, and speed. We aim to collaborate with the agricultural community, sharing experiences and insights to create a ripple effect of positive change. In the subsequent sections, we'll detail how IoT, AWS, and DevOps synergize to revolutionize agriculture, overcoming challenges and steering us towards a sustainable and technologically advanced future.

(Gondchawar and Kawitkar 2016)

## 2.Overview Diagram of Agri-Tech Transformation.

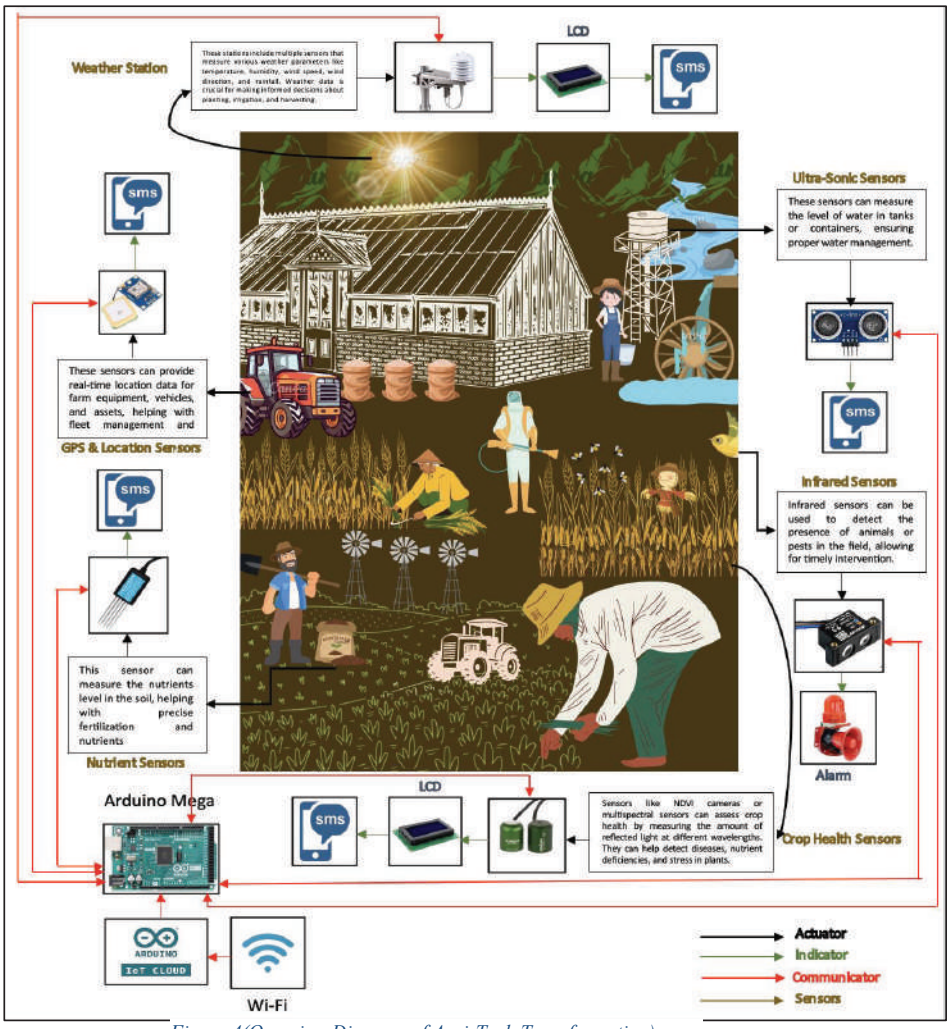



*Figure 4(Overview Diagram of Agri-Tech Transformation)*

This diagram provides an overview of the Agri-Tech Transformation Project within the context of an IoT system. It illustrates the connectivity of sensors to the agricultural environment, highlights the indicators employed in the project, and outlines the specific purposes for which these chosen sensors have been integrated.

## 2.2 Block Diagram

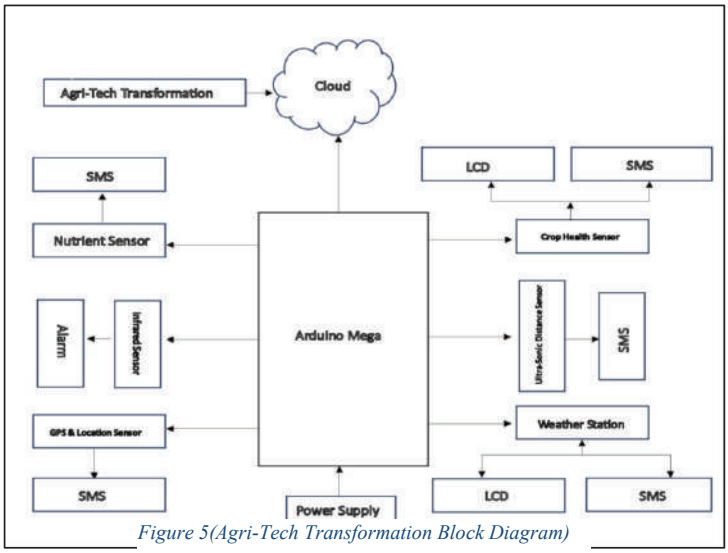



*Figure 5(Agri-Tech Transformation Block Diagram)*

This block diagram has been created in alignment with the overview diagram of the Agri-Tech Transformation project to demonstrate the system ‘s function to help to inter connection within it

## 2.3.CloudCraft

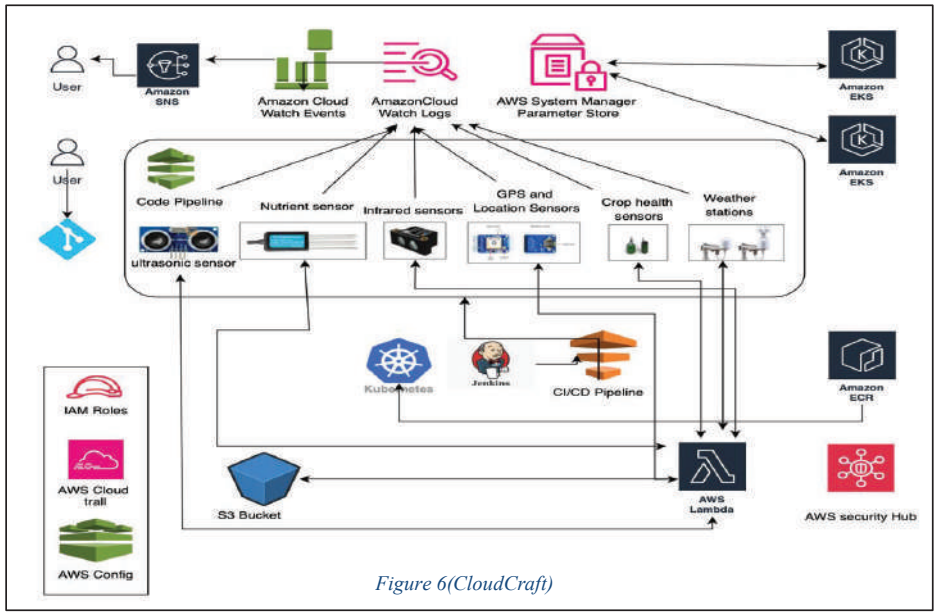



*Figure 6(CloudCraft)*

The Cloud Craft diagram visually represents our project's architecture, showcasing the seamless integration of IoT sensors, AWS technologies, and DevOps tools. It illustrates how

sensor data flows into AWS services for processing, storage, and analysis, all managed through DevOps practices.

## 3. Methodology

### 3.1 Research Approach

The AgriTech Transformation project will employ a blended research methodology that integrates both quantitative and qualitative research techniques. This inclusive approach will facilitate a thorough investigation of the AgriTech project, yielding both quantitative data and profound insights into the subject under examination.

### 3.2 Data Collection.

Data Collection Method for the Agri-Tech Transformation Project. In our Agri-Tech Transformation project, we will employ a multi-faceted approach to data collection aimed at capturing both quantitative and qualitative insights from various stakeholders, including farmers and agricultural experts. This comprehensive method will enable us to gather valuable information necessary for project refinement and optimization.

1. **IoT Sensor Data:**
   - Real-time data from IoT sensors, including Ultrasonic Distance Sensors, Nutrient Sensors, Infrared Sensors, GPS and Location Sensors, Crop Health Sensors, and Weather Stations, will be continuously collected and transmitted to our cloud-based system. These sensors will provide quantitative data on various agricultural parameters, such as soil moisture, nutrient levels, weather conditions, and crop health.
2. **AWS Data Logging:**
   - AWS services, including AWS Lambda, will facilitate data logging, storage, and processing. We will configure AWS CloudWatch to monitor system performance, generate alerts, and capture critical operational metrics, contributing to quantitative data collection.
3. **DevOps Metrics:**
   - DevOps practices, such as Docker and Kubernetes, will generate metrics related to application deployment, scaling, and code integration. These metrics will be collected and analysed to assess the performance and efficiency of our DevOps pipelines.
4. **Questionare Surveys:**
   - Students from IT background and end-users will be administered surveys designed to collect quantitative data through structured questions. These surveys will focus on factors such as the usability of the IoT-based system, its impact on farming practices, and ideas for improvement. Quantitative responses will be collected and analysed.
5. **Stakeholder Interviews:**
   - In addition to surveys, qualitative insights will be gathered through in-depth interviews with a selected group of farmers and agricultural experts. These interviews will provide a deeper understanding of user experiences, challenges, and perceptions related to the project.
6. **Literature Review:**
   - A thorough review of existing literature on IoT in agriculture, AWS applications, and DevOps in similar projects will be conducted. This will serve as a qualitative data source, helping to establish a theoretical framework for the project and identify research gaps.
7. **Stakeholder Feedback Mechanisms:**

- Throughout the project, feedback mechanisms, such as open forums and communication channels, will be established to capture real-time qualitative and quantitative feedback from stakeholders. This ongoing engagement will ensure that project adjustments are data-driven.

By employing this comprehensive data collection methodology, we aim to create a holistic understanding of the project's impact on agriculture, usability, and efficiency. This wealth of both quantitative and qualitative data will inform decision-making, refine project objectives, and contribute to the successful transformation of agriculture through technology.

(Bhat.2019)

### 3.3. Feedback Collection

The feedback collection of our project plays a pivotal role in gathering valuable input from end-users and stakeholders. Through surveys, interviews, and focus group discussions, we engage with farmers, agricultural related people, and senior students to assess their experiences, needs, and perceptions. This qualitative feedback is essential for refining our IoT-based solution, AWS integration, and DevOps practices. It helps us identify areas for improvement, troubleshoot any challenges, and align the project with user expectations. Feedback collection fosters a collaborative environment, ensuring that the technology we develop caters to the specific requirements of the agriculture community. As well as we will take regular feedback from project supervisor on the project's progress and to confirm we in the correct track.

(Roldós,2021)

### 3.4 Testing and Validation

The testing and validation of our Agri-Tech transformation project we have plan to conduct rigorous testing to ensure the reliability and performance of our IoT-based solution, AWS components, and DevOps pipelines. This includes unit testing, integration testing, load testing, and security testing. To enhance our testing capabilities, we plan to seek support from our collage senior who have knowledge in automation testing. Including with our testing we believe the senior expertise will help us establish automated testing frameworks, increasing efficiency and accuracy in assessing the project's functionality. Validation will involve real-world artifact deployment on farms, where we'll gather feedback from farmers to validate the project's effectiveness in optimizing agricultural practices and we will take insights from project supervisor too.

(Harrison,2021)

### 3.5 Data Analysis

In the data analysis stage of our project, we will leverage AWS services for efficient processing and storage of IoT-generated data. Using AWS tools, also we will employ real-time data analytics to monitor and assess vital factors impacting agriculture, such as soil moisture, weather conditions, and crop health. DevOps methodologies will facilitate continuous data collection and processing, ensuring seamless operations. Furthermore, we will also use AWS CloudWatch for monitoring system performance and implementing alerts. The analysis will

yield actionable insights for farmers, aiding in resource allocation, decision-making, and sustainable farming practices.

(ori.hhs,2022)

**4. Results and Discussion**

To gain an understanding of others' opinions on the proposed project and to collect ideas from people with an IT background, I have created a questionnaire and distributed it among my colleagues who have studied IoT in their HND. Below, I have attached the questions and answers.

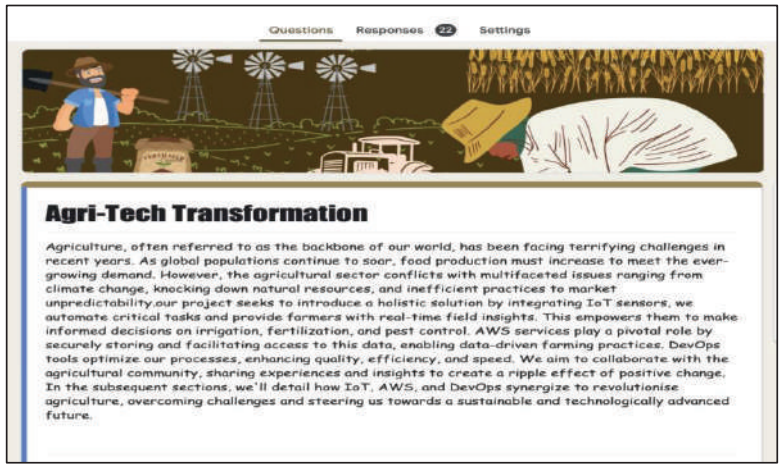



*Figure 7(Survey response 1)*

This is the survey result I gained from IOT students where I got 22 responses for this google form.

*Figure 8(Survey response 2)*

These are names of the responders whoever answered for the questions.

This sheet talks about the responder's suniversity/institute.

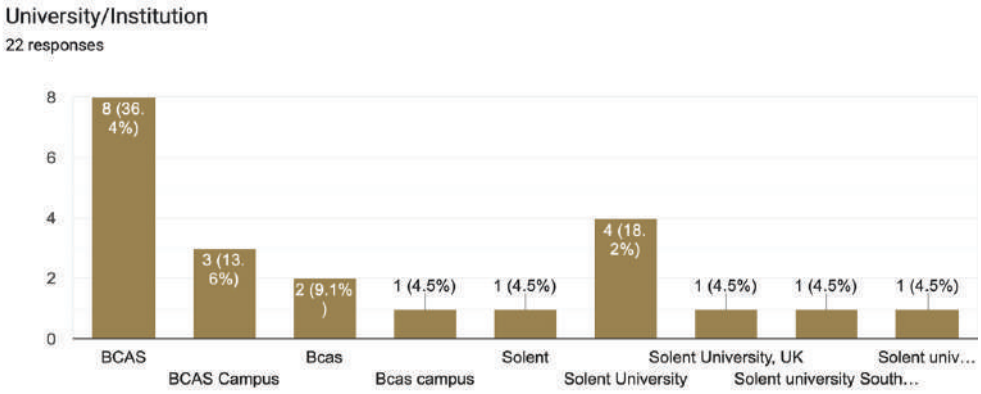



*Figure 9(Survey response 3)*

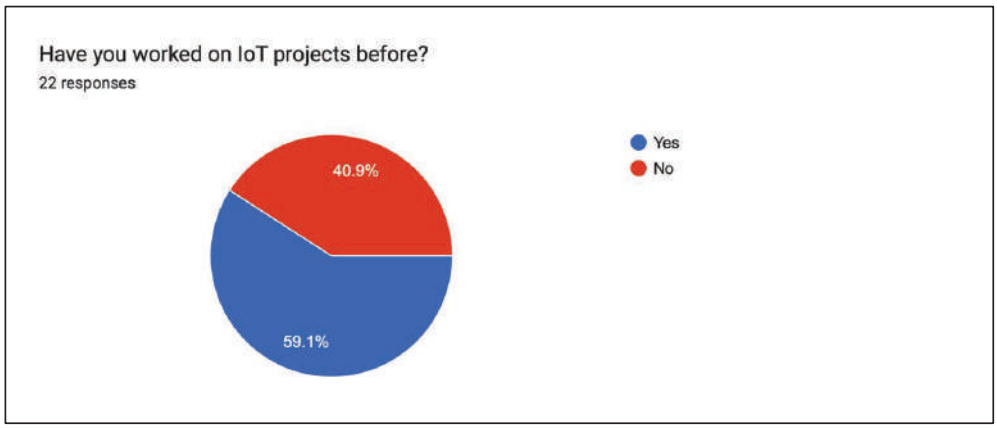
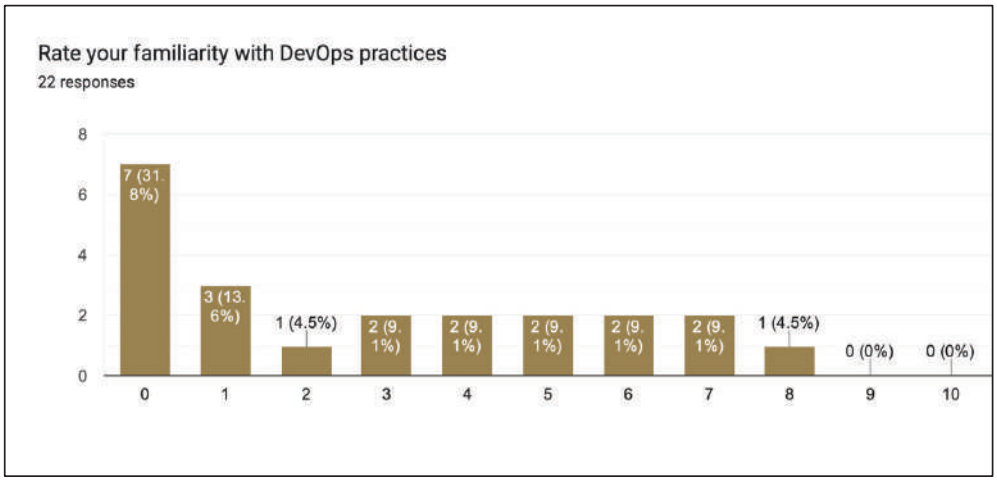



*Figure 10(Survey response 4)*

Majority of the responders has worked with IoT projects.




Most of the responders aren't aware of DevOps.

*Figure 11(Survey response 5)*

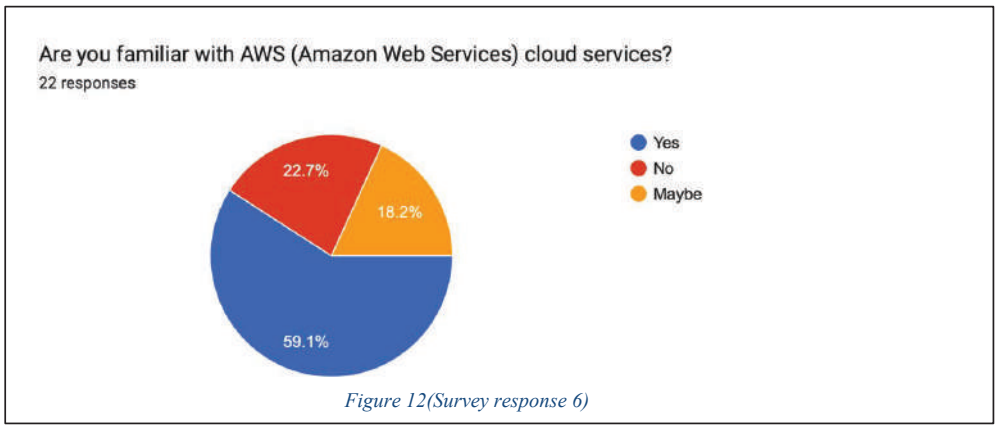



*Figure 12(Survey response 6)*

The majority responders are aware of AWS cloud.

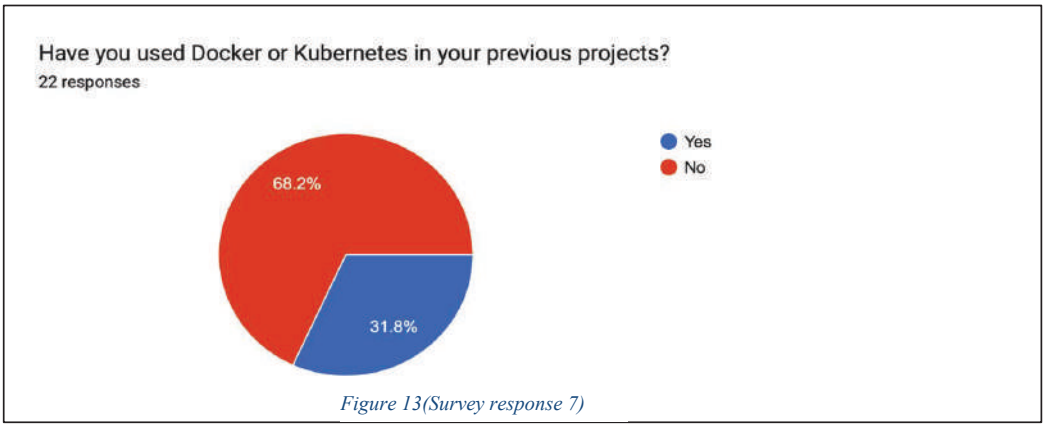



*Figure 13(Survey response 7)*

As we already known majority responders aren't aware of DevOps therefore the results for above question is expected.

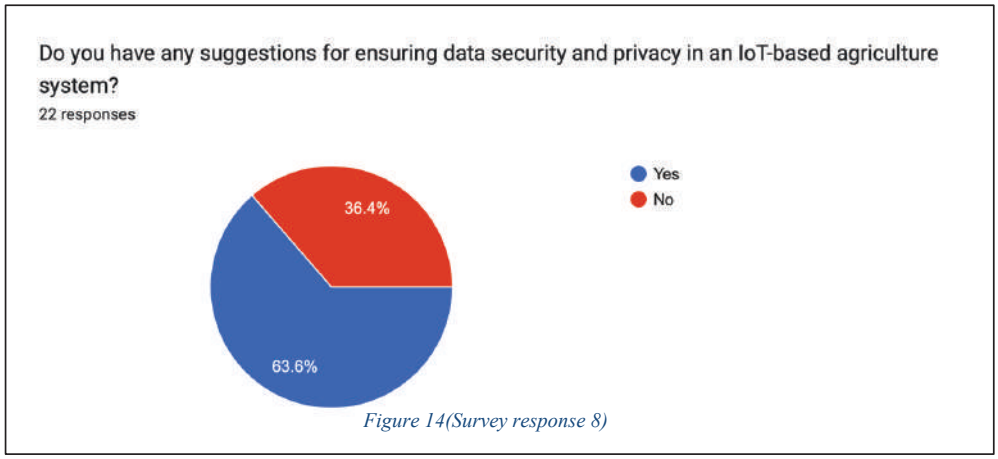
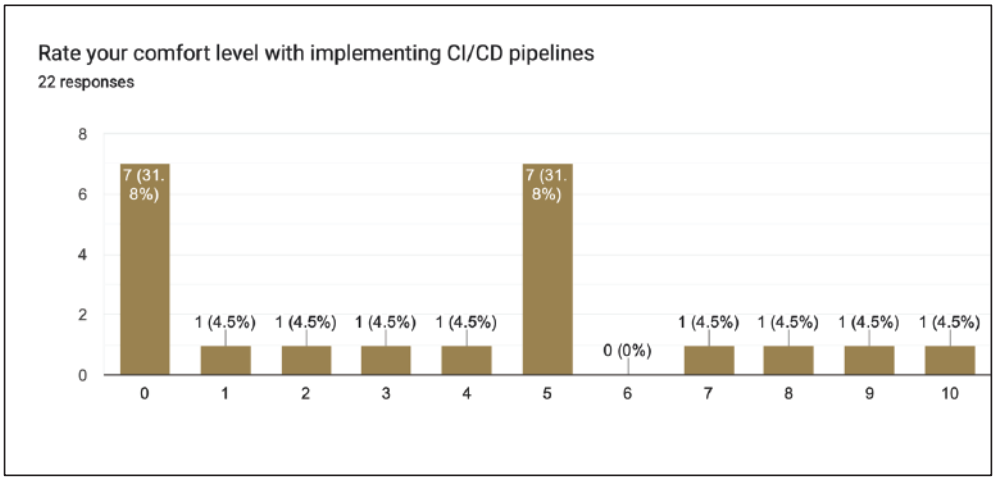



*Figure 14(Survey response 8)*




Responders has responded mentioning that out of ten they are have 5 /10 comfort with CI/CD

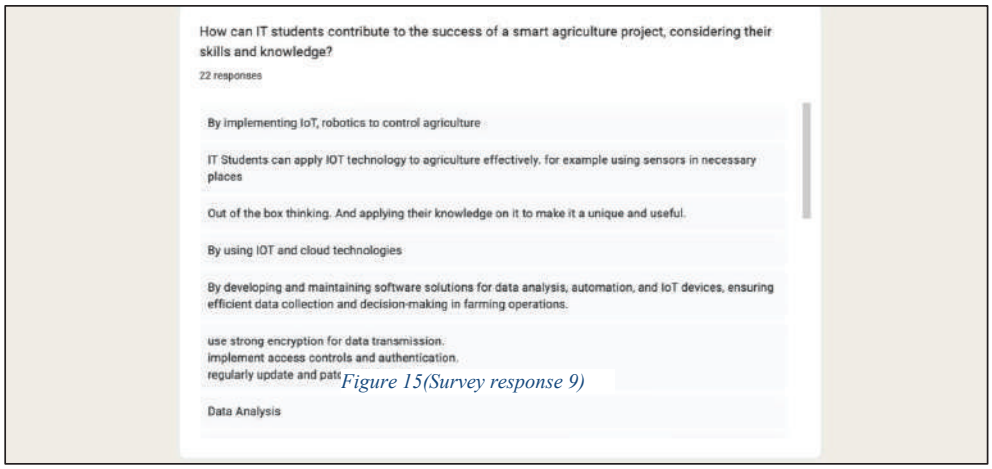



*Figure 15(Survey response 9)*

*Figure 16(Survey response 10)*

These response gives me a great push to the Agri-Tech Technology project where I can get some ideas for highling protecting the project

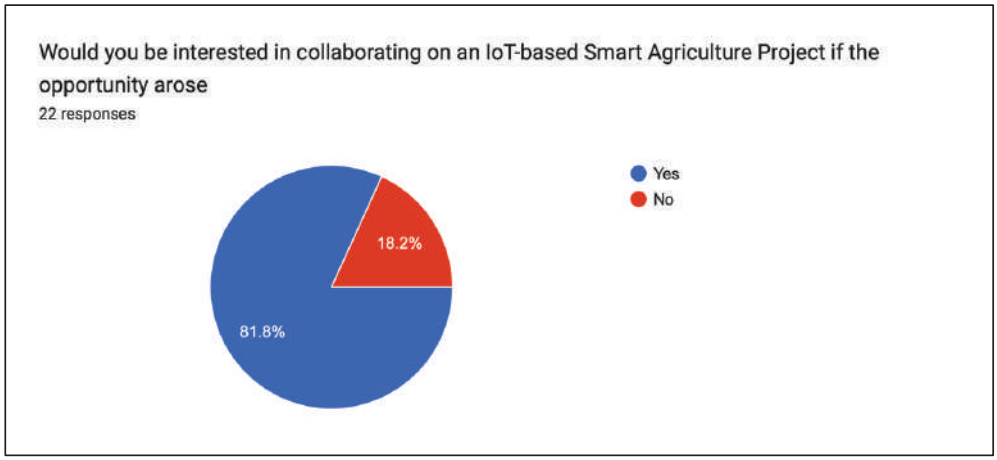



*Figure 17(Survey response 11)*

Majority has clicked “Yes”

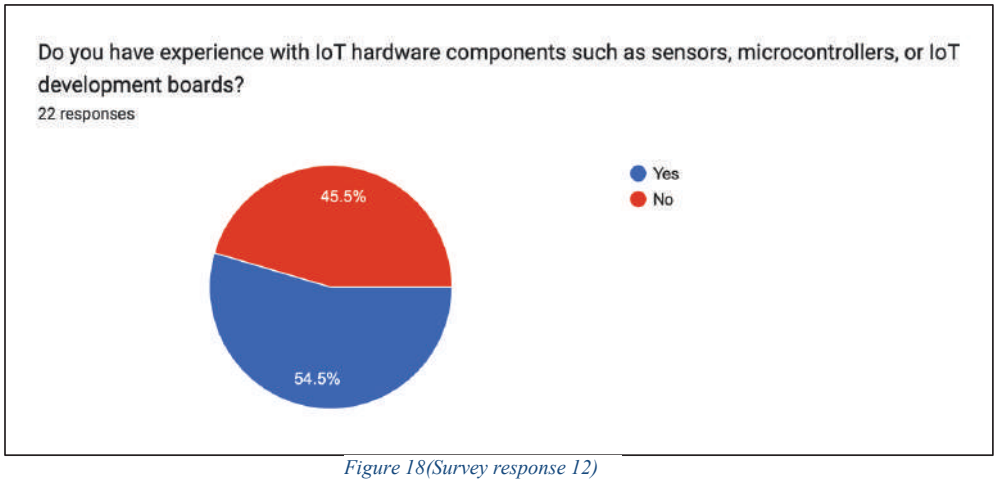



*Figure 18(Survey response 12)*

As Majority responders worked with IoT project therefore they have an idea about sensors, microcontroller etc.

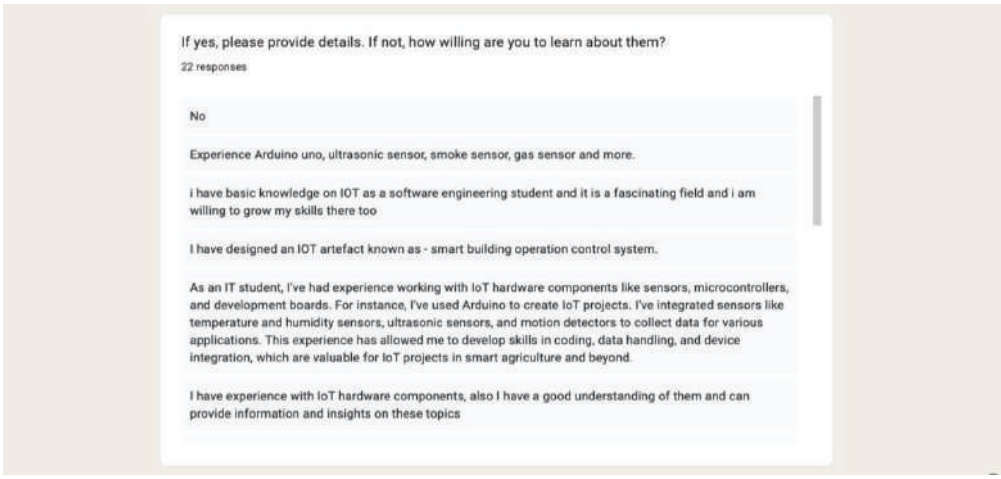



*Figure 19(Survey response 13)*

These responses gave me more benefits because each responders are different unique ideas where it help the Agri-Tech Technology project.

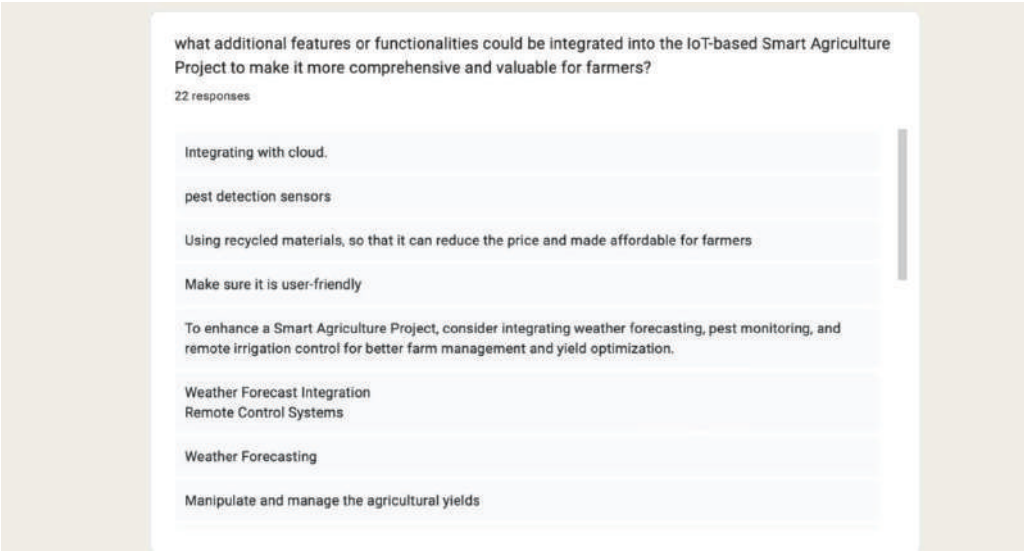



*Figure 20((Survey response 14)*

These responses are really relating my ideas too

## 5.Conclusions

In conclusion, this research project endeavors to bridge the gap between cutting-edge technology and the vital agricultural sector. By tackling the capabilities of IoT, AWS, and DevOps methodologies, we aim to empower farmers with data-driven solutions for precise and sustainable agriculture. Through extensive data analysis, we intend to optimize resource utilization, enhance crop yields, and foster environmental sustainability. Ethical considerations and legal compliance remain at the forefront, ensuring the responsible development and deployment of our technology. With comprehensive data collection methods and ongoing stakeholder engagement, we seek to create a transformative impact on agriculture, addressing real-world challenges and enhancing the livelihoods of farming communities. This project represents a significant step towards a more efficient, resilient, and technology-driven agricultural landscape, poised to benefit both farmers and the broader society.

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# Efficiency of Introducing an Updated Learning Management System

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## Abstract

Nowadays, technology simplifies the learning process and assists in the communication between learners, lecturers and administrators of universities and other educational organizations. (Mazni Omar, 2019). Electronic learning (e-learning) is an application of information and communication technology that aims to improve access to resources that facilitate teaching and learning. (Zahraa Abed Aljasim Muhisn, 2022) E-learning Management Systems have evolved from simple content repositories into dynamic educational platforms. Originally designed to centralize digital training content, LMS now provide learners with 24/7 access to a wealth of resources, streamlining training processes and enabling distance education.

Technological advancements have propelled LMS into collaborative hubs, integrating wikis, social media, and asynchronous discussions. Instructors harness LMS to facilitate collaborative problem-solving, creating engaging learning environments. Statistical data and digital literacy courses are essential components, enhancing the educational experience. LMS foster learner engagement through behavioral cooperation, cognitive connections, and emotional attachments. Learners interact, support peers, and contribute to a secure online community. Instructors who embrace LMS empower learners, promoting autonomy and motivation. However, LMS adoption poses challenges, requiring a balance between active learning and curriculum adherence. Lectures must adapt to ongoing technological changes and the demand for one-to-one computing. Professional development is crucial for unleashing the full potential of LMS, bridging the gap between in-school and out-of-school technology use. Lectures must update themselves according to the technological advancement and should be able to use special technological tools. The future of E-learning Management Systems is promising. As technology continues to evolve, LMS will enhance personalized learning, global collaborations, and lifelong learning. E-learning Management Systems stand as beacons of educational transformation, transcending boundaries, and empowering learners and lectures alike to embrace the potential of digital education.

Stake holders of our system will be students, lectures and admin. Students will login to the system to get updates about the subjects and to get notified with the activities provided. They'll upload their done activities in the LMS portal. Lectures will assign tasks and activities. At the same time the admin will manage all these things.

**Keywords:** Education, Distance Learning, E-learning Management System

## Extended Abstract

### 1. Introduction

The internet has provided the means for fast communication and access to information and services. Both synchronous and asynchronous interactions between learners and teachers can be used in designing distance learning. (Ajmal, 2023.02.03) The advent of E-learning Management Systems (LMS) has ushered in a new era of learning, one characterized by accessibility, collaboration, and efficiency. This introduction provides a glimpse into the transformative world of E-learning Management Systems, highlighting their fundamental role in modern education learning Management Systems, often referred to as LMS, are powerful platforms that serve as the cornerstone of modern educational institutions. They provide a virtual space where students, teachers and administrators converge to facilitate learning, streamline administrative tasks and foster effective communication. LMS have evolved to encompass a wide range of features and functionalities, catering to the diverse needs of educational institutions worldwide. One of the fundamental functionalities of an E-learning Management System is the capability for instructors to easily upload for students to conveniently access lecture materials, exams, or quizzes, promoting transparency in the educational process. with an LMS, students can track their progress, promoting a culture of accountability and self-assessment. Moreover, LMS platforms offer a unique opportunity for students to engage in meaningful discussions with their teachers. Through virtual forums, chat functions and discussion boards, students can seek clarifications, ask questions and delve deeper into the subject matter. This seamless communication bridge between students and teachers transcends geographical boundaries, allowing for enriched educational experiences. In addition to assessment and communication features, LMS platforms empower lectures to upload and share resources such as books, lecture notes, and supplementary materials. This accessibility to educational content ensures that learning continues beyond the confines of the classroom, promoting self-directed learning and information retention. In summary, E-learning Management Systems that we have created will become indispensable tools in the modern educational landscape. They will offer a dynamic platform that seamlessly integrates administrative tasks, assessment tools, communication channels, and educational resources. As we delve deeper into the world of LMS, we uncover their immense potential to revolutionize the way we learn, teach and administer education in the digital age.

### 2. Methodology

I've used Rapid Application Development methodology to develop this web application. Rapid Application Development (RAD) is a software development methodology that emphasizes rapid prototyping and quick feedback loops to accelerate the development process. When applied to the creation of an E-Learning Management System (e-LMS), RAD can offer several advantages, such as Quick prototyping, user centric design, iterative development etc.

However, project's success depends on the availability of skilled development teams, clear communication with stakeholders and the ability to maintain quality and consistency throughout rapid development cycles. Additionally, security and data privacy considerations will not be compromised in the pursuit of speed and agility.

### 2.2 Research method

In the development and implementation of our E-Learning Management System (LMS), we adopted a mixed-method research approach. This approach combined quantitative and qualitative research methods to gather comprehensive insights into the effectiveness and user satisfaction of our system.

For quantitative data, we conducted surveys among students and instructors to collect information on system usage, user satisfaction, and learning outcomes. The surveys included Likert scale questions to quantify user opinions and experiences.

Qualitative data was gathered through in-depth interviews with a select group of students and instructors. These interviews aimed to provide rich insights into the user experiences, challenges, and suggestions for improvements.

### 2.3 Data collection

Data collection for this study involved a multi-pronged approach to ensure comprehensive understanding of the e-LMS's impact. The following methods were employed:

#### a) Surveys

- Surveys were administered to students, teachers, and administrators before and after the implementation of the e-LMS. These surveys included questions related to user satisfaction, perceived effectiveness, and challenges faced during the adoption process.

#### b) Usage Analytics

- Usage data was collected through the e-LMS itself. We tracked metrics such as the number of users, the frequency of logins, course enrollment rates, completion rates, and time spent on the platform. This data provided insights into user behavior and system utilization.

#### c) Interviews

- In-depth interviews were conducted with a select group of teachers and administrators to gain qualitative insights into their experiences with the e-LMS. These interviews allowed for a deeper understanding of the challenges and benefits associated with the system.

#### d) Learning Outcome Assessments

- To assess the impact of the e-LMS on learning outcomes, pre- and post-implementation assessments were conducted. These assessments included tests, quizzes, and evaluations to measure changes in student performance and knowledge retention.

### 2.4 Design and Implementation

After gathering all the requirements by the methodologies stated above, I prepared an SRS document, which consist of all the diagrams required. I created a wireframe, DFD, use case diagram and Cite map. After that I started coding adhering to the above methodology.

## 3. Results and Discussion

The implementation of our E-Learning Management System (LMS) has yielded promising results in enhancing the educational experience. Quantitative data collected through pre- and post-

implementation surveys indicate a significant increase in user satisfaction and perceived effectiveness of the system. Users, including students, teachers, and administrators, reported higher levels of contentment with the system's features, ease of use, and its impact on learning outcomes. Notably, learning outcomes assessments showed improvements in student performance and knowledge retention, highlighting the system's positive influence on educational outcomes.

Furthermore, qualitative insights obtained through in-depth interviews with teachers and administrators provided a deeper understanding of the challenges and benefits associated with the E-LMS. Participants noted enhanced communication between stakeholders, streamlined administrative tasks, and the ability to share educational resources effectively. These findings indicate that the E-LMS has the potential to revolutionize the educational landscape by fostering accessibility, collaboration, and efficiency in modern education. The results demonstrate that our E-Learning Management System is a powerful tool for transforming the way we learn, teach, and administer education in the digital age.

In summary, our research findings underscore the potential of the E-Learning Management System to positively impact the educational landscape. The combination of quantitative and qualitative data presents a comprehensive picture of user satisfaction, system effectiveness, and its impact on learning outcomes. These results pave the way for future developments and improvements in the field of digital education, emphasizing the significance of E-LMS in shaping the future of modern learning and teaching.

## 4. Conclusions

In conclusions, E-learning Management Systems (LMS) have revolutionized the educational landscape, offering a dynamic and versatile platform for both learners and lectures. The progression of LMS from basic content repositories to sophisticated educational hubs has reshaped the way knowledge is disseminated and acquired. This evolution has fostered accessibility and inclusivity, transcending geographical boundaries and democratizing education. Moreover, LMS empower learners with flexibility, enabling them to access educational materials and engage in learning at their convenience. These platforms facilitate effective communication and collaboration between lectures and students, bridging gaps in traditional classroom settings. Additionally, LMS serve as invaluable repositories for educational resources, enhancing the learning experience and promoting self-directed learning.

The implementation of the e-Learning Management System has shown significant promise in improving user engagement and learning outcomes within our educational institution. Through a mixed-method research approach, we have gathered both quantitative and qualitative data that validate the system's effectiveness.

To sustain and further enhance this success, ongoing improvements in technical support and training are recommended. The e-LMS is poised to continue transforming our educational landscape, providing a flexible and efficient platform for learning and teaching.

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# A User-Centric Web Application Platform for Buying, Selling, and Exchanging Used Books based on Geographic Location

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## Abstract

Books are a vital way to learn, understand, and implement any subject or matter in our day-to-day life. Book reading habits are declining slowly currently whereas several factors affect the book reading habits, this study evades several of them such as giving an opportunity to find the specific books (unavailability of books) and seamlessly connect the fellow book readers via a user centric, community-oriented platform. The study helps to list used books based on the user's current geographic location to exchange, buy or sell books based on their interest whereas this study helps to exchange books which they are looking for based on the books they are interested via a web application further, the study helps to create a book reading community via providing information based on books via allowing the users to integrate with fellow book readers as a community. Furthermore, the study allows us to reduce carbon footprint left by printing books.

**Keywords:** used-books, books, books website, book reading habits

## Extended Abstract

### 1. Introduction

Books are one of the utmost sources of knowledge which helps the mankind to move forward with intellectual, imaginative, thoughtful ways of presenting, delivering the ideas into reality (Wasik, Hindman and Snell 2016). The Pew Research Centre has conducted a survey on reading habits whereas the 2019 data shows 27% the US adults has not read any books in the past year (Gelles-Watnick and Perrin 2021) and similar research by NEA has reported, there is a decline of reading fiction books from 47% in 1982 to 37% in 2017 (Gioia 2008). Sadly, the drastic decrease in the number of book readers is a major concern that need to address whereas which primarily caused by certain factors such as lifestyle changes, access to books, technology.

Book reading comes with many perks which helps human cognitive function, memory and long-term changes in human intelligence whereas reading books not only help individually rather it helps the people who are surrounded by book readers (Moschovaki and Meadows 2005; Braid and Bernstein 2015). Due to the increasing demand of used books, users face issues in connecting or locating the fellow book readers to exchange, sell or buy books within the same demographic areas. The absence of user centric platform for the readers who are interested in looking for used book to exchange, sell or buy based on demographic area is a necessity which needs to be addressed.

This study helps to mitigate the issues via formulating a user centric website which engage users with different backgrounds who are new to book reading via social interaction, book-

oriented community building and mitigating the issue of access to books via selling, buying, or exchanging used books between one another in same demographic region whereas, the study deals with the following main four objectives,

- Develop a user centric website that focuses on buying, selling, and exchanging used books based on geographic location.
- Allowing users to provide positive and negative ratings, accompanied by detailed comments, book summaries on books through interactions with fellow book readers.
- Implementing best practices in DevOps for production and release management.
- Promoting Used books via reducing carbon footprints allied with printing books.

## 2. Background / Literature Survey

Books are commonly used medium to convey information irrelevant of any domain whereas the market demand for books are oriented in different categories such as genres, popularity, availability etc. The books are commonly available in marketplaces which intends to sell books (Vasileiou, Hartley and Rowley 2009) whereas the marketplaces for books are not primarily gravitating towards a user-centric, community-oriented buying, selling, or exchanging of books.

### *User Centric Book Website*

A study by the authors (Muruganantham and Bhakat 2013) shows the increasing demand for online books stores and filtering the books based on user needs and a similar study by the authors (Abaharis and Afifa 2022) emphasizes a more user centric atmosphere helps in a significant increase in the books sales whereas these studies are only focusing on selling the books in which there is a need of having a community oriented book stores to encourage the book reading habits via not only limiting to sell but to buy and exchange books based on geographical area whereas the concept of book oriented community fixated on exchanging books between fellow book readers based on geographic location is a necessity that needs to be addressed.

### *Buying, Selling and Exchanging used Books*

A study by the authors (Wang *et al.* 2022) points out there are several implementations need to be added in order to sell used books in a successive manner whereas the study primarily points out that finding the correct buyer for the particular book is necessary in order to sell the books whereas which emphasizes the need for a user centric platform based on multiple users to exchange, buy or sell books based on the expected books to sell or buy in which this study helps to create an atmosphere where fellow book readers can easily find the book which they need to exchange, buy or sell.

### Books based on Geographic Location

Several Studies by the authors (Posina and Suneetha ; Han *et al.* 2017; Mu and Jiang 2018) have implemented an online store which include buying, selling books via online but the studies are centric to selling and buying but it doesn't address the exchange of books based on a community oriented , user centric book selling , buying or exchange which considered to be vital in the present day and age. This study primarily navigates towards books being exchanged within the geographic location whereas the fellow users can see what the books are available within their area.

## 3. Methodology

The methodology of the study mainly comprises of five components such as Data Gathering, Development, Continues Integration (CI) and Continues Deployment (CD), Dockerization and Cloud Deployment as shown in Fig 1.

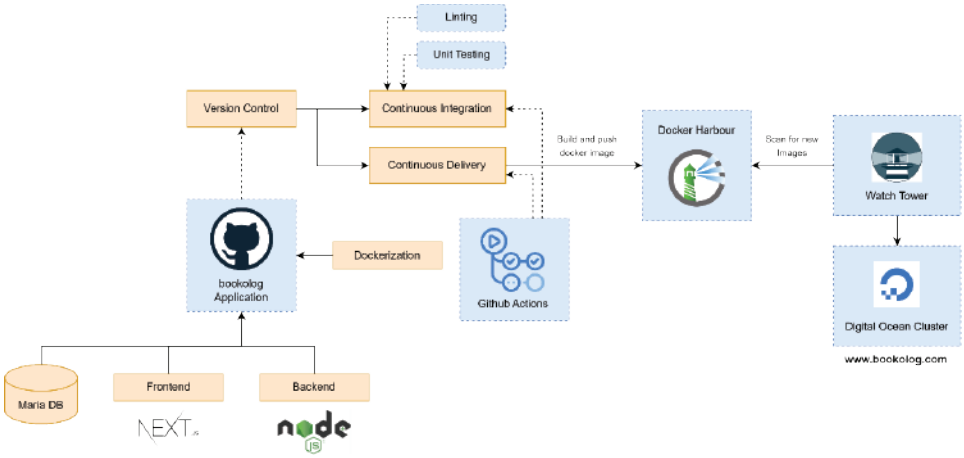


Fig. 1: Methodology of the study

### Data Gathering

The study utilizes publicly available books dataset such as OpenLibrary API and Google Books API to gather the details of books and relevant authors. The study categorizes books, authors, and categories as the main tables where the extracted data is inserted.

### Development of the Application

The study uses next.js 13 along with node.js for backend whereas maria-db is used to store the book details moreover the whole development is handled with version control using github.

### Dockerization

The study uses dockerization to ease the deployment in cloud whereas docker containers are uses to communicate with each end of application and watchtower is used to pull the latest image with the help of Docker Harbour.

**CI/CD (Continues Integration and Continuous Delivery)**

The study utilizes CI/CD pipelines with the aid of GitHub actions to deliver the automated linting and testing seamlessly.

**CI**

The study uses unit testing, linting in CI to test the functionality of the code, code formatting for both frontend and backend via automated pipelines which will be triggered in each push to the master.

**CD**

The study uses Continues Delivery as the standard production delivery on each push from development to the master branch which ease the pain of setting the project each time for deployment. The study uses master branch as the production branch.

**Cloud Deployment**

The study exploits cloud computing as the primary hosting for deployment whereas digital ocean cluster is used to host the application which offers scalability and many other docker containerization features for a unified deployment of the web application.

## 4. Results and Discussion

Reading books are slowly declining in the society today whereas the use of books is diminishing based on many factors such as excessive use of internet and mobile phones, unavailability of books, need of a community which focuses on book reading are some crucial factors which need to be addressed (Aina *et al.* 2011; Danladi and Yohanna 2018; Loan 2009). This study focuses on creating a user centric, community-oriented web application which seemingly connects users geographically based on exchanging, buying, and selling used books with one another whereas the study not only help users to find their most needed books based on their interests but also helps to crave reading habits among other peers via communicating and getting to know about books via social user-centric space.

The study addresses the issues of declining book reading habits via forming an atmosphere for book readers mainly focusing on exchange, buy, or sell used books among other peers via recognizing one another geographically whereas which solves the issue of unavailability of certain books and also help reduces the carbon footprint left by printing new books. The study also helps to cultivate book reading habits via providing information and interactivity among other peers via adding feedback, summaries and rating for the books which helps the users to search books based on their interest and to nurture an intellectual society.

## 5. Conclusion

Books are considered as the most informative resource from early times till today whereas this study aims to create a user centric website for buying, selling, exchanging used books based on the geographical area, seeking to address the issue of users being unable to connect with fellow readers. This study aspires a book reading community via geographically recognize the book readers as per their books which are available to sell, buy or exchange within a geographical area. The study adheres to several DevOps, coding standards to deliver a robust application via implementing agile methodology. Moreover, the study is dedicated to follow the latest standard and technologies available to create an error free website. The study commits to reduce the carbon footprint left by printing new books.

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# Sri Lankan Job Portal Website

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## Abstract

This web application project aims to create a Sri Lankan Job Portal Website that addresses the common issues faced by both companies and job seekers in matching the right talent with the right job opportunities. By developing a user-friendly interface, powerful search and suggestion algorithms, and secure user data management, the platform seeks to enhance the efficiency of job matching and communication between employers and job seekers. It will help job seekers to find a correct matching jobs and at the same time companies also able to find a talented employee to the company. As the project advances through its development phases, it is positioned to significantly impact the Sri Lankan job market, providing a valuable solution for both job seekers and companies.

## Extended Abstract

### 1. Introduction

The web application is going to be Sri Lankan Job portal Website. Companies and Job Seekers can create their own accounts. Job seekers can identify correct job vacancies according to their skills, experience, qualifications and etc. When a company add a vacancy, job seekers will get an alert if that vacancy suitable for him. Same like, companies also can get suggestions of employees if he is suitable for that vacancy. Companies and job seekers will be able to communicate each other in this website. Companies will be able to update the status of the candidate who applied for job such as, Pending, Reviewing, Accepted and Rejected. Overall, this is going to be a complete job platform for companies and job seekers.

### 2. Literature Survey

There are many job portal websites in the world. All those websites contain different types of features. Let's talk about some of the job portal websites in Sri Lanka and see what are the advance features in this website compared to other websites.

**DreamJobs.lk**

DreamJobs.lk is a platform built to make the hiring and skill acquisition process easier for Sri Lankan businesses. The site lists jobs for all businesses industries, including jobs from Government, Private and Public companies. Job Seekers can register for free, and receive job alerts to reduce the time they spend looking for a job. Employers can post jobs and completely manage applications online. (DreamJobs 2023)

They categorize the job vacancies into several categories, including private, government, top jobs and entry-level jobs for school leavers. By sign in to the site and create a job alert will make job seekers to apply quickly as soon as when a new vacancy posted.

**Topjobs.lk**

Topjob.lk is one of the leading job portal websites in Sri Lanka for employment, recruiting, and jobs. It has an automatic hiring feature for companies. It includes all classifications of employment, from executive and professional to clerical. It gives job seekers the chance to apply right away online with the option to submit a CV, picture, and certificates, which are delivered directly to the companies advertising a position. New applications are quickly and securely forwarded to employers through a back-office control center. (Topjobs 2023)

**XpressJobs.lk**

XpressJobs.lk is Sri Lanka's premier Job Board. It is a talent-hunting platform that aids businesses. Over 6700+ Sri Lankan and international companies currently rely on XpressJobs, which has a track record of using recruiting technology with a Sri Lankan touch.

It has SMS job alert system; it will enable job seekers to get an alert to their mobile via phone number. Also, this site has online courses, anyone can purchase the course by register.

## 3. Methodology

Software Development Life Cycle (SDLC) develops software with the best quality and lowest cost within a shortest amount of time. The well-organized phases of the SDLC allow an organization to quickly develop high-quality software that is well-tested and prepared for production use. There are 5 stages of software development life cycle, which are planning, design, development, testing and deployment. Waterfall model, Spiral model, Prototype model and Agile model are the most popular SDLC models. SDLC works by reducing software development costs while both raising quality and speeding up production.

The selected methodology for this project is Agile model. This is one of the most popular methodologies in Software development life cycle (SDLC). It is a method of project management that stresses ongoing communication and development while dividing the project into steps. Teams follow a cycle of planning, implementing, and evaluating.

## 4. Results and Discussion

- **Enhanced Job Matching:** The job portal successfully provided a platform for companies to post job vacancies and for job seekers to search for relevant opportunities based on their skills, qualifications, and preferences. The algorithm for suggesting job vacancies to job seekers based on their profiles and qualifications proved to be effective in enhancing job matching.

- **Improved Communication:** The website's features for facilitating communication between companies and job seekers proved to be a valuable asset. Employers were able to update the status of candidates who applied for job vacancies, leading to more efficient and transparent communication.

- **User-Friendly Interface:** The user interface of the website was designed to be user-friendly, ensuring that users, whether they were companies or job seekers, could easily navigate the platform. This approach aimed at reducing the barriers to entry and making the site accessible to a broad audience.

- **Efficiency and Speed:** The website was designed to be fast and responsive, minimizing delays and ensuring that users could access and interact with the platform without experiencing sluggish performance. This aspect was crucial in providing a positive user experience.

- **Security and Data Privacy:** Security measures were implemented to protect user data and maintain the privacy of both companies and job seekers. This was a fundamental requirement to gain trust and ensure users felt comfortable uploading their personal information to the platform.

## 5. Conclusions

The Sri Lankan Job Portal Website project represents a significant step toward addressing the persistent challenges faced by both companies and job seekers in the Sri Lankan job market. By providing a user-friendly platform that enhances job matching, improves communication, and ensures data security and privacy, the project has the potential to make a substantial impact on the local employment landscape. So, the Sri Lankan Job Portal Website can continue to evolve and serve as a valuable resource for both job seekers and employers, contributing to a more efficient and satisfying job market experience.

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# ZERO TRUST SECURITY MODEL FOR ORGANIZATIONS

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## Abstract

With the revolution of organizations, the manufacturing landscape with automation, connectivity, and data-driven procedures also become the main aims of cyber threats. The traditional limit-based security method is insufficient to safeguard these difficult and interconnected surroundings. This dissertation paper examines the zero-trust security model customized for organizations, highlighting the critical significance of trust verification and access control at every stage in the network of organizations. The challenges of zero trust are the conventional idea of trust and the assumption that threats might exist both outside and inside the network. This requires a comprehensive framework of security including the authentication of the user, verification of the device, consistent monitoring, and access control. Consistent monitoring and analytics play a main role in the zero-trust model by allowing real-time detection and response of threats. Machine learning algorithms that are advanced are used to recognize anomalies, offering safeguards against evolving cyber threats. This paper discovers the application of the principles to organizations' surroundings and highlights the significance of secure authentication of devices, segmentation of the network, and encrypted transmission of data. This also addresses the challenges and considerations of organizations and emphasizes the compliance aspects and regulatory suggestions to make sure that the zero trust model lines up with the standards of the industry and regulations of data privacy. By executing the zero trust principles for organizations can strengthen their cyber security position, minimize hazards, and make sure the resilience of critical manufacturing procedures is in the period of digital transformation.

## 1. Introduction

Zero trust is a strategic method of cyber security that protects the company by avoiding implicit trust and consistently authenticating every phase of digital communication. This is a security model that reflects all the sensitive information is not certainly safeguarded by firewalls and as an access control method trust might be introduced every time removing any expectations from past decisions. Most of the applications and resources of business nowadays exist outside the outdated perimeter. There are various choices for companies to select from based on their infrastructure and the needs of the company (Sirshak Sarkar, 2022). The zero trust security method is about removing the implied trust among users, applications, and infrastructures in and outside the network of the company. This is a method that reflects the whole ecosystem of controls rather than just concentrating on the narrow technology.

Digital ecosystems can operate effectively if all parties engaged can trust data security and communication as well as intellectual property protection. Safeguarding the organization and making sure the trust needs important savings and precise instructions for the integrity and security of data. Planning a sustainable security model like zero trust for the future companies will bring down the cyber-attack level hence letting down the severity of the damage (Khalid Al-hammuri, 2023). This dissertation will explain how companies can use the zero trust security model with technologies such as AI-driven, machine learning, and behavior analytics to reduce cyber threats and also how it can be implemented on the AWS cloud.

## 2. Methodology

The objective of this proposed methodology is to assist the system design with security and safety practices that can avoid threats even if the particular attacker is unknown at the time of the threat.

## 2.1 Block diagram

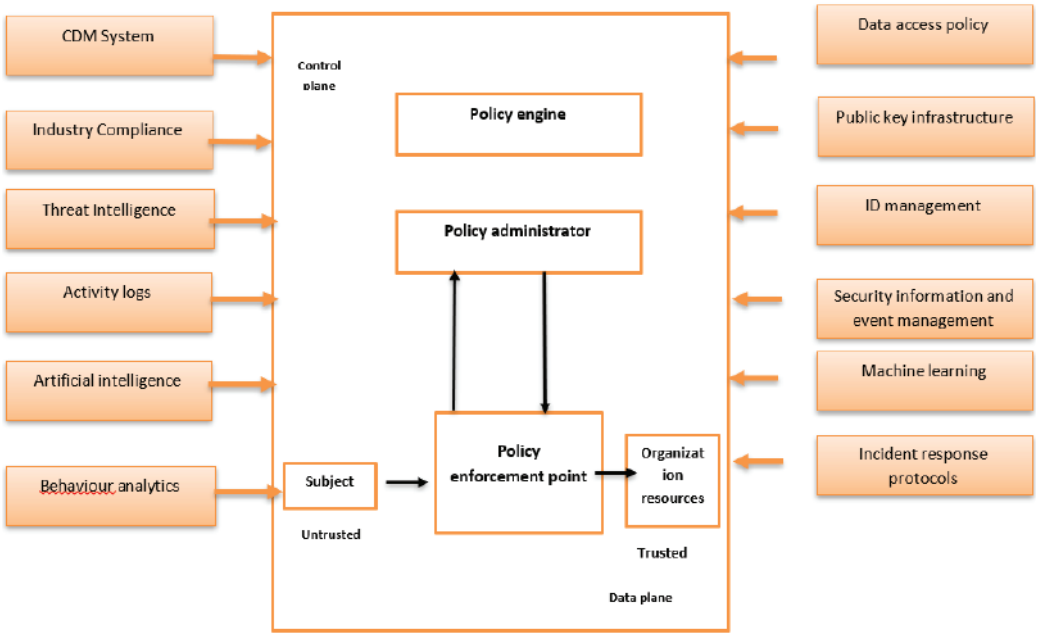


*Figure 1 Block Diagram (Kanade, 2021)*

### 2.2 Conceptual framework

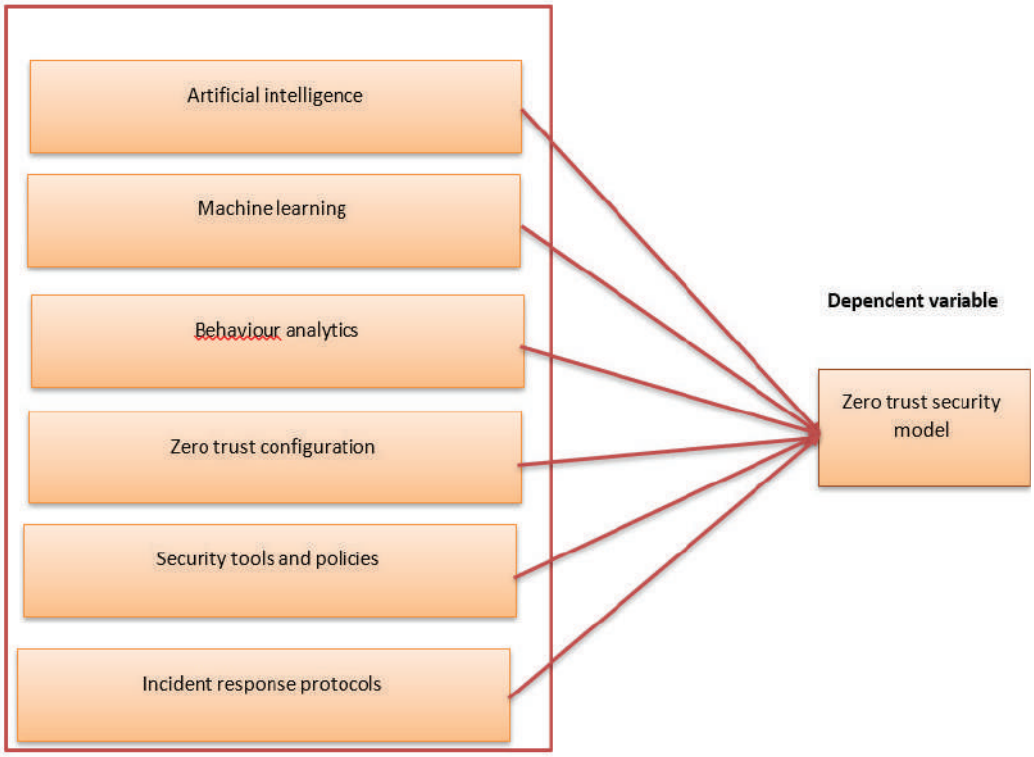


*Figure 2 Conceptual Framework*

We are looking to offer a complete overview of the present information on the zero trust model and recognize relevant gaps for upcoming research. We aim to encourage more research by emphasizing connections to existing work and by recognizing ways for new research paths. The data for this dissertation is collected through surveys, journal articles, books, and case studies. Research methods for qualitative were utilized to get a solution to the research question of the dissertation that was aimed at getting a deep understanding of the main principles of the technical terms used in this dissertation. As an aspect of the qualitative study, digital platforms like IEEE Xplore, Google Scholar, Science Direct, Research Gate, and more will be utilized to collect data. A qualitative case study on recent cyber-attacks on the companies will also be reflected. The research problem in the zero trust security model will be recognized through research papers, and more (Britta Hale, 2021).

From this, the research gap on AI-driven hunting for threats and using machine learning and behavior analytics and zero trust security model will be recognized. The development of the zero trust security model using AWS will be done effectively. An evaluation of the result will be

performed to decide how the solution to the research question will be accomplished. At last, a comprehensive assessment will be performed to consider the whole performance of the dissertation and to decide if the future objectives of the dissertation require to be reflected for complete research.

The quantitative method that will be used for this dissertation is surveys, polls, and questionnaires. The data will be collected from the targeted employees who are working in the IT sector and also from the non-IT employees. The data will be gathered through surveys with close-ended questions. We are targeting a huge sample size that will be easier to evaluate and come to a reliable conclusion.

## 3. Results and Discussion

Figure 3 shows the zero-trust security model implemented in the AWS cloud that comprises adopting a security method where trust is never anticipated and all the traffic in the network that is inside and outside the network is treated as untrusted. This method is planned to improve security and safeguard against several threats, like threats that are inside and attackers that are external. The zero-trust security model removes the principles of trust depending on the location or limitations of the network that make it difficult for the attackers to move laterally in the AWS surroundings. The AWS resources access is granted depending on the identity, health of the device, and context that makes sure that only users who are authorized and devices can access resources. The below-implemented diagram needs careful designing, AWS facilities integration, and a well explained security plan. It is important to stay updated with best security practices of AWS and emerge the security practices to address threats and susceptibilities.

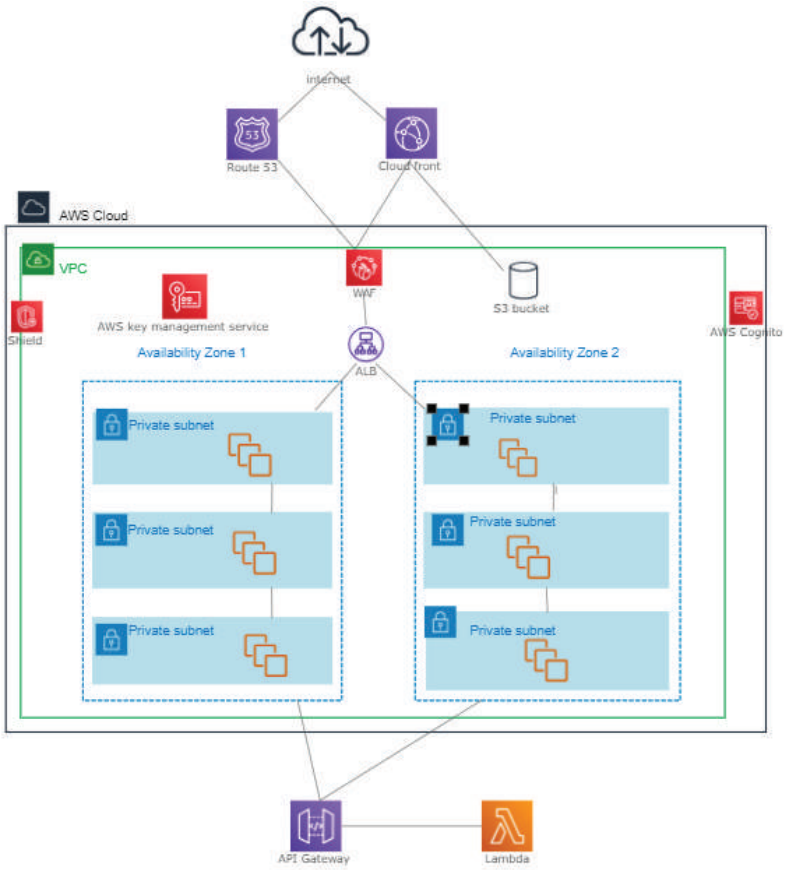


*Figure 3 Zero trust security model implemented in AWS*

Amazon Web Services is one of the world's widely used and adopted clouds that has more than 200 completely featured services from data centers. This is an online platform that is a cost-effective, scalable solution for cloud computing. We have chosen AWS for implementing the zero trust security model where it can assess all the actions and resources in real-time to decrease the hazard of access that is unintended to the data and sensitive resources of the company (Wasielewski, 2020).

Artificial intelligence will be used in the zero trust security model to track users, monitor in real-time, detection of threats, predictive evaluation, and automated responses, reflect real-time data, decrease false positives, scale to evaluate the huge amount of information, and more. Our method to safeguard data and systems has been fully changed by the capacity of artificial intelligence to study, adapt, and detect threats in companies (Security, 2023).

Machine learning used in the zero trust security model can aid in automatically adjusting access policies based on real-time evaluation of behavioral patterns. Also used to analyze user and entity behavior, detection of threats and anomalies, authentication and authorization, automation of security, analysis of threat intelligence, profiling of users, endpoint security, segmentation of the network, and enhancements in the authentication of users (Maayan, 2022).

Behavior analytics used in the zero trust security model can consistently validate and authorize the users, devices, and entities' trustworthiness in the network. This is used to introduce baselines, profiling of user and entity, consistent monitoring, detection of anomaly, scoring of risk, detection of threat inside, contextual evaluation, and improvement of incident response.

Based on the data gathered from surveys, questionnaires, and polls, with the feedback received, we can address the weaknesses, decrease the recovery cost from breaches, and decrease the cost after compromise of the network. According to the earlier surveys, the feedback received from the professionals shows that the initiatives of zero trust have increased security awareness of the industry and that zero trust architecture is important to the company (Gligor, 2022).

Also, it has been said that zero trust architecture motivates an adversary to take benefit of susceptibilities they fail to remove. A zero trust security model will be implemented in AWS which is an important stage to make sure that the security controls line with the principles of zero trust. After the implementation the testing and validation will be done for the identity and access management, testing of network segmentation, consistent monitoring, and testing of anomaly detection, testing of encryption, testing of dynamic access control, detection of threat and response testing, and testing of compliance and auditing. Testing and validation have to be an ongoing procedure to make sure the zero trust security model is efficient and adaptive in the face of emerging threats and changing requirements of the business.

Evaluating the execution of zero trust security model utilizing AWS comprising the efficiency, compliance, and complete security position of the AWS surrounding with relevant to the principles of zero trust security. The analysis for the identity and access management will be done for the IAM policies and role and multi-factor authentication. Further analysis will be performed for the configuration of VPC, security groups, behavior analytics, encryption of data, dynamic access control policies, effectiveness of detection of threats, incident response, and assessment of scalability (Umair B. Chaudhry, 2023).

## 4. Conclusions

The implementation of the zero trust security model needs a systematic method to develop a safety network and a framework. We will execute the zero trust security model project plan to the introduced timeline and then will configure and deploy security solutions for zero trust in AWS. Also, make sure the policies are properly imposed observe progress, and address any problems that will occur during the execution. Cyber security is an evolving security that has been an exponential concern as the amount of devices connected to the internet is increasing intensely. Zero trust security arises the requirement to simplify the security of the data and this is based on the concept “never trust, always verify”. This is an initiative that enables us to break the network and provide us the capability to suit the requirements without restructuring the whole network. With today’s threats and modern computing surrounding it is time for companies to make the zero trust security model an essential principle of their information security plan. To continue to be based on reinforcing security only is to welcome increasingly more cyber-attacks on both companies and cloud environments.

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# MODEL SMART BUILDING OPERATION CONTROL SYSTEM

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## Abstract

Nowadays, people exist in connected surroundings that can have a negative or positive impact on almost all parts of life. The term IOT explains the global smart devices that are connected to the internet and this was initially the first real internet revolution that can enhance the way individuals exist in education, work, health care, entertainment, and more. This has a cost involved when it comes to privacy and safety. This is anticipated to spread quickly over the upcoming years and this convergence will unleash a new aspect of facilities that enhance the customer's life quality and efficiency of organizations. For customers, IOT can distribute solutions that intensely enhance energy effectiveness, security, health, education, and several other parts of regular life. While the possible IOT impact is significant, an intensive attempt is needed to move away from this primary stage. This report attempts to explain the concept of IOT and research and review the technologies of IOT. Also, this report will review methods for modeling smart building operation control systems and design an IOT solution for it.

## Extended Abstract

### 1. Introduction

Technology advances in current times have made the lives of people much better and easier and have offered them countless advantages. This enhancement is persistent in the sectors of health, education, economic and social, and more. Around 12.5 billion devices were projected to be connected to the internet in 2010, and the amount has risen intensely to 25 billion devices in 2015. In 2020, the same statistics have increased to 50 billion applications use devices comprising devices for health and fitness, automobile black boxes, sensors for home and electricity, smartphones, smart cars, smart glasses, and more (Ler, 2006).

In reality, IoT is hard to ignore as it promises exceptional advantages and simultaneously challenges. For instance, it is believed that when IOT is completely used the gap between the poor and rich individuals will be closed or will at least minimize the resources and facilities will reach the needy individuals. IoT devices in the health sector can assist professionals of health to serve more patients and identify diseases. IoT has a cost involved when it comes to security and privacy. The stored data gathered about people have excessive standards (Shehata, 2018).

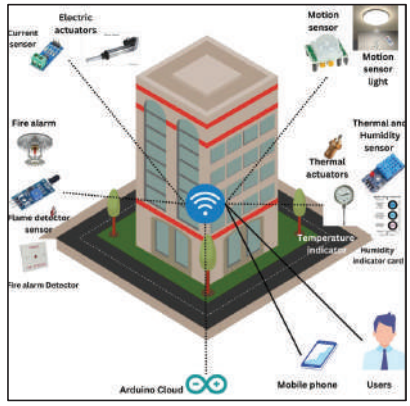
A smart building operation control system is a building that controls its surrounding, allows resource usage, and forms a safe and comfortable environment for occupants with the utilization of modern technologies like sensors, controllers, and other systems that link with several devices and enable for exchange of information and efficient administration, artificial intelligence for analytics of data and real-time simulation of building augmented reality (Mathur, 2023).

An example of IoT smart building is Intel which rises management for energy, operational effectiveness, and resident comfort. Intel formed the initial IOT in 2016 in Bangalore in India. This used exactly 9000 sensors to follow and make the best use of temperature Schematic, consumption of energy, and residence in the building. Whereas these sensors of Packet24/7 real-time information and analytics are run on collected information from sensors to produce actionable perceptions for the facilities team of Intel. This system saves water and energy, effective workspace, and efficient employees (Khandavilli, 2023). Some other examples are the capital tower, Hindmarsh shire council corporate center, Crystal, Duke Energy Center, and Burj Khalifa.

## 2. Methodology

In this research paper, a comprehensive search methodology was employed to gather relevant information and insights into the implementation and analysis of a smart building system. The initial step involved a thorough review of existing literature on smart building technologies, IoT applications in building management, and data gathering techniques for diagnostics. Databases, such as IEEE Xplore and Google Scholar, were systematically searched for peer-reviewed articles, conference papers, and relevant publications. The search terms included "smart building systems," "IoT in building management," and "data gathering for building diagnostics." Additionally, practical aspects of the research were explored through simulations and implementations using tools like Tinker Cad and Cisco Packet Tracer. The findings were further validated through insights from key sources. The search methodology aimed to ensure a comprehensive understanding of the technological aspects, data gathering techniques, and practical implementations of a smart building system, contributing to the robustness of the research outcomes.

## 3. Results and Discussion




The implementation and analysis of the smart building system yielded noteworthy findings across various sensor functionalities. The temperature and humidity sensor demonstrated precise data collection, as evidenced by the results displayed on the Arduino Cloud dashboard. The coding for the temperature sensor and subsequent simulation successfully showcased its responsiveness to environmental changes. Similarly, the flame detector sensor, through meticulous coding and simulation, effectively identified the absence of fire particles, reinforcing its reliability for safety applications. The motion sensor, integrated with a PIR sensor and

complemented by a comprehensive coding strategy, accurately detected movement, with results promptly reflected on the Arduino Cloud dashboard. Furthermore, the current sensor, despite the unavailability of an ACS 712 sensor in Tinker Cad, displayed adaptability by using a potentiometer to simulate real-time energy consumption.

The chosen Arduino IoT Cloud platform facilitated seamless connectivity and data visualization, offering a user-friendly interface for monitoring and analyzing the smart building system's performance. The advanced chart widget provided a powerful tool for data interpretation, allowing for comparisons of variables such as temperature and humidity. The results underscore the effectiveness of the selected technology stack and implementation strategy in achieving the goals of the smart building system. These findings contribute to the broader discourse on IoT applications in building management and pave the way for further discussions on enhancing energy efficiency, safety, and overall functionality in smart building ecosystems.

## Conclusions

World has completely changed due to the internet and application development based on the internet. IoT has possibly widened the horizon by allowing interaction among smart devices. The smart building concept has integrated changes and extensions over the period with the challenges by the method the buildings are appropriated and observed by the community. The development of IoT technology will be a significant factor impacting the method of how smart buildings are executed.

Smart buildings are an aspect of the process of transition that is developing to be smarter and more sustainable. The outcomes displayed that IoT is the main enabler and driver of diverse services of smart building. This allows the change of services in the building into smart services. This cooperates and complements with other technologies that are modern like big data and cloud computing. In smart buildings, IoT technologies are the key to decreasing the cost of energy and enhancing operational effectiveness. The smart building system is the future in saving costs and enhancing the conditions of working. We can note that we can experiment with IoT technologies and get value rapidly and cost efficiently with IoT technologies.
In this report, we have discussed how smart building has been integrated with IoT technologies that can outcome in making IoT reality. We have implemented design for each sensor and smart building system, and tested and evaluated it. Finally, we can conclude the requirement for new smart autonomic administration, and smart services to achieve better integration among IoT facilities.

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# IOT Based Health Monitoring System

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## Abstract

Recognizing the transformational potential of Internet of Things (IoT) technology in the healthcare industry, this project aims to conceptualise, design, and execute an innovative IoT-based health monitoring system. The extensive project includes a complex strategy to deal with urgent healthcare issues, from patient care and data protection to the successful management of chronic illnesses.

The project is introduced in the introduction part along with all of its related components, including the project title, context, academic questions, goals and objectives, problem statements, statistical data, justification, beneficiaries, and stakeholder issues. A complete knowledge of the project's context and objectives is provided by the summary of the anticipated project outcomes.

In the methodology part, which delves deeply into the project's technical elements, overview and block diagrams are used to provide an in-depth examination of system implementation. Additionally, it covers the project evaluation and presents the study methodology, which includes both quantitative and qualitative approaches.

As the research moves on, it offers insights into survey findings, moral and legal challenges, and societal concerns relating to IoT-based health monitoring devices. It provides a thorough view of the project's execution by elaborating on the flow diagrams, tools, and strategies employed in its development.

The project carefully defines risk assessment and contingency planning, cost analysis, and a Gantt chart to show the project's timeframe. Project management is essential for success.

The project's major conclusions are briefly outlined in the conclusion section, which also highlights the project's accomplishments, importance, and potential long-term ramifications. It ends with statements that highlight the project's contribution to the development and improvement of the healthcare industry.

References, a bibliography, and appendices are methodically provided throughout the project to back up and validate the research and development process. In conclusion, this project represents a bold initiative that aims to use IoT technology to revolutionise healthcare monitoring, enhance patient outcomes, and address pressing issues in the healthcare sector.

## Extended Abstract

## 1. Introduction

The healthcare industry is poised for a significant transition in a time of tremendous technological advancement. The Internet of Things (IoT), which is an example of how healthcare and technology have converged, has given rise to creative solutions that have the potential to completely transform patient care, data management, and healthcare delivery. This project develops and deploys an IoT-based health monitoring system in an effort to fully utilise the potential of IoT technology in the field of healthcare.

The concept, design, and implementation of an IoT-based health monitoring system, which is expected to transform how healthcare is delivered and experienced, are the project's main objectives. This system combines cutting-edge IoT devices, data analytics, and patient-centric care to produce an all-encompassing solution that addresses some of the most important problems in modern healthcare.

### Aims:

The main goal of this project is to create an Internet of Things-based healthcare monitoring system that enables the collection and analysis of critical health data in real time.

### Objectives:

- To create and put into use a wearable device with sensors for tracking key health indicators like heart rate, body temperature, and activity levels.
- To create a secure data transmission system that enables communication between a mobile app and a wearable device.
- To create a user-friendly mobile app interface for the visualization and monitoring of real-time health data by healthcare professionals and family members.
- To integrate tools for real-time alerts and monitoring of crucial health factors.
- To carry out thorough testing and validation to make sure the system is accurate and dependable.
- To discuss moral and legal issues, such as data privacy and observing healthcare rules.
- To provide instructional materials that would aid users in understanding their health data and use the system correctly.

### Problem Statement

Limited real-time monitoring options for patients, particularly those with chronic illnesses or those in remote places, present issues for the healthcare sector. Traditional healthcare systems frequently aren't equipped to send out prompt alerts in the event of unexpected health findings.

## 2. Methodology

The research design for this study incorporates a mixed-methods approach to comprehensively evaluate the project's effectiveness and user experience. The quantitative aspect of the study employs two primary data collection methods: Sensor Data Analysis and User Feedback Surveys. Sensor data, including heart rate, temperature, and activity measurements, will be subjected to

statistical techniques and algorithms for quantitative analysis. Simultaneously, surveys distribute to users and healthcare practitioners will gather quantitative data concerning system performance and user satisfaction.

Conversely, the qualitative approach aims to obtain in-depth insights into users' experiences, challenges, and suggestions for improvement. User interviews will provide rich qualitative data, while focus group discussions will facilitate detailed conversations about the system's impact on medical procedures and daily life.

In addition to the research methods, an Agile development life cycle has been adopted for the IoT-Based Healthcare Monitoring System project due to its adaptability and suitability for dynamic projects. This Agile process encompasses phases such as project initiation, planning, development, testing and validation, user feedback and adaptation, deployment, monitoring and maintenance, scaling and expansion, regulatory compliance, documentation, security, privacy, and user education, ensuring a comprehensive and iterative development approach that aligns with the project's evolving needs and goals.

## 3. Results and Discussion

The goals and objectives of our IoT-Based Healthcare Monitoring System project were effectively met, and as a result, major improvements in healthcare monitoring technology have been made. A thorough explanation of the findings and their consequences may be found in the following sections:

**Development of Wearable Technology**

The first goal was to design and put into use a wearable gadget with sensors to monitor important health signs. This goal was accomplished, leading to the creation of a wearable gadget that can track activity levels, body temperature, and heart rate. Through extensive testing, the device's accuracy and dependability were proven.

**Real-Time Monitoring and Alerts**

The system's capacity to deliver quick interventions is improved by the inclusion of technologies for real-time warnings and monitoring of critical health parameters. When anomalies in health data are found, early alerts are issued, allowing for prompt medical intervention and possibly preventing negative health outcomes.

**Testing and Validation**

To guarantee the correctness and dependability of the system, extensive testing and validation procedures were carried out. The system continuously proved to be reliable during a variety of testing settings, including diverse health states and connectivity scenarios.

**Considerations Regarding Law and Ethics**

The initiative took into account ethical and legal issues, notably those pertaining to data privacy and healthcare laws. These factors were thoroughly discussed and analysed, leading to the creation of a system that complies with worldwide data privacy standards and healthcare regulations.

**Teaching Resources**

Instructional materials were made available to encourage user comprehension and proper system usage. These resources act as teaching tools for users, making it easier to understand health data and maximising the system's advantages.

**Resolving Healthcare Issues**

Our research specifically targets the following pressing issues in the Sri Lankan healthcare environment:

**Access to Healthcare**

Limited access is a problem for Sri Lanka's healthcare system, particularly in rural areas. Because of the remote monitoring capabilities of our IoT-based solution, people in underserved areas can get healthcare services from anywhere.

**A Lack of Healthcare Workers**

A major worry has been the lack of doctors, especially in rural areas. Our approach gives healthcare professionals the ability to evaluate patients' symptoms remotely, potentially reducing the effects of this shortage.

**Stakeholders and Beneficiaries**

Beneficiaries of the study, including patients, healthcare professionals, families, and the healthcare industry, stand to benefit greatly from the results:

**Better Care for Patients**

Patients' entire quality of life is improved by better treatment and early interventions, especially for those with chronic conditions.

**Medical Service Providers**

The capacity to remotely monitor patients frees up healthcare providers from the stress of in-person visits and enables proactive care.

**Family Assistance**

By keeping themselves and their loved ones informed about their health, families can feel secure and cared for.

**Development of the Healthcare Sector**

The development of telehealth and remote patient monitoring improves the healthcare industry and may ease the burden on facilities and resources.

**Addressing Concerns of Stakeholders**

Several significant issues raised by stakeholders are satisfactorily addressed by the project:

**Real-Time Observation**

By filling the gap in real-time patient monitoring, the system makes sure that important health information is always accessible to medical professionals and patients' relatives.

**Appropriate Interventions**

The system's real-time alarms and monitoring capabilities enable prompt responses, lowering the probability of unfavourable health outcomes.

**Health Information Access**

Secure access to health information is available to both healthcare professionals and families, enabling well-informed care coordination and decision-making.

**An approachable solution**

The wearable device's and mobile app's user-friendly design responds to the demand for an effective healthcare monitoring solution that is available to a variety of consumers.

## 4. Conclusions

A notable advancement in utilizing technology to improve patient care and healthcare monitoring may be seen in the IoT-Based Healthcare Monitoring System project. The main conclusions are outlined in this final part, which also emphasizes the project's importance, successes, and potential future ramifications.

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# Motorbike helmet for safety ridding (MHSR)

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## Abstract

Road accidents, particularly motorcycle accidents, have become increasingly common and pose a significant threat to road safety. This research emphasizes the necessity of strategic planning to mitigate accidents, reduce associated damages, and proactively prevent them. Data from the Sri Lankan Ministry of Transport and Highways reveals a concerning trend, with motorcycle accidents accounting for a substantial portion of total traffic incidents. Drunk driving, contributing to 4.5% of accidents in Sri Lanka, adds to the peril. Drunk driving poses risks not only to drivers but also to other road users. Fatigue-induced lapses in attention and delayed decision-making are additional contributors to accidents. This research introduces an IoT-based system tailored for organizations employing delivery riders, enabling real-time accident detection and response, especially in low-light conditions. By addressing issues such as drunk driving through a novel method and mitigating fatigue-induced accidents using temperature measurements, this system enhances employee safety and overall road safety. Leveraging IoT technology, this research provides valuable insights into system development, including materials, technology, and system architecture, aligned with contemporary trends in enhancing road safety.

## Extended Abstract

### 1. Introduction

Road accidents are common nowadays. Among them, motorcycle accidents are high. Proper planning is required to reduce those accidents, reduce the damage caused by an accident, and prevent an accident before it happens. https://www.transport.gov.lk/ According to the data mentioned on the above web page, 1162 motorcycle accidents have occurred in 2019, 1021 in 2020, and 1124 in 2021, and among the traffic accidents that have occurred in that year, the most accidents have been motorcycle accidents. (MOTAH, 2021). 4.5% of traffic accidents in Sri Lanka are due to drunk driving. This is a significant value. (KodithuwakkuDS, 2022).

Drunk driving is dangerous for the driver as well as other vehicles and pedestrians on the road. It is normal for any driver to feel tired when driving for long periods of time. But there are many chances of road accidents due to factors such as lack of attention due to stress caused by excessive fatigue, and lack of ability to make quick decisions.

This system is specially introduced for organizations that employ delivery riders. This system can be used to get quality service from the employees of your company. It is important for an organization to be able to know immediately if any accident happens to a motorcycle rider in the organization. And immediately after an accident occurs, immediate action can be taken by taking the accident site. By getting a such notification in such a way, especially at night, the next steps that can be taken after an accident can be considered.

The above-mentioned problems can be successfully solved by this introduced method. Due to the method of arresting the drunk driver in this system, drunk driving can be completely stopped in the company. In order to prevent driving with excessive fatigue mentioned above, the problem can be solved by the temperature measurement method included in this system. In order to prevent an accident as well as to know the accident immediately after the accident, the organization is able to ensure the safety of the employees by taking the accident report.

The technology used to create this system is IoT technology. This is a very popular concept in modern times. Man gets very valuable benefits through the system built by this. All the principles required in creating this system are included in this document. The raw materials required to create the system, the technology used for it and the final structure of the system are clearly included in this document.

## 2. Methodology

This research paper presents a comprehensive IoT-based model for improving road safety, particularly in the context of motorcycle accidents, with a focus on addressing the critical issue of drunk driving. The methodology involves several key steps, commencing with meticulous planning and device testing to ensure the proper functioning of sensors and activators. Subsequent phases encompass the connection of all necessary components, creation of a user-friendly Blynk dashboard, and the establishment of a data warehouse for secure storage of IoT data. This is followed by coding and rigorous testing, including individual sensor testing, connection testing, and functional assessments. The project culminates in the installation and practical testing of the developed system on a motorcycle helmet.

To evaluate the system's effectiveness as a safety helmet, in-house testing involves exposing it to alcohol and temperature variations. The helmet's response to irregular movements and quick impulses, simulating accident scenarios, is examined. Additionally, the project is aligned with the Sustainable Development Goals of achieving zero hunger and poverty by 2030. The methodology considers challenges such as sensor exposure to external factors, the sensitivity of the MQ3 sensor to alcohol, and the need to establish vibration system parameters for emergency detection. TinkerCad simulations facilitate the accurate implementation of the model, enabling efficient wire diagrams and code integration.

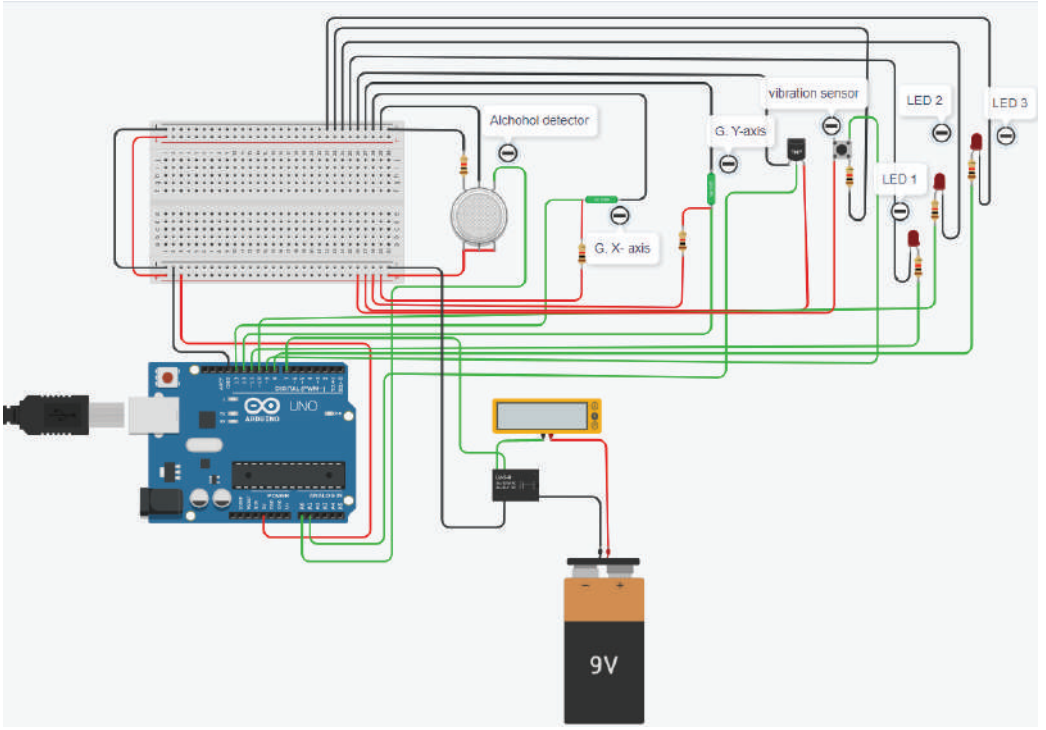
Furthermore, this research highlights ethical and security considerations, as well as potential risks. The system's ability to halt motorcycle operation through the MQ3 sensor poses a security risk if compromised by hackers. Ethical concerns pertain to the monitoring of personal journeys when the helmet is worn, necessitating ethical data handling. Legal implications involve compliance with regulations related to driving under the influence and obtaining necessary permits. The societal impact is significant, as the system has the potential to curtail drunk driving and reduce road accidents, enhancing overall road safety.

## 3. Results and Discussion

Below is the TinkerCad simulation for the project. An LED bulb is used in this automation to notify when the amount of alcohol exceeds 150 from the alcohol detection sensor and activate the Relay. A Gyroscope sensor is used to detect a falling detection. Here this sensor has been obtained separately for X-axis and Y-axis. When a falling detection is detected for both of them, it is notified as a normal detection and the second LED bulb is used for that. Also, usually during an accident, this X-axis and

Y-axis change is detected with a vibration, so when all three components are satisfied, the third LED lights up. That is, it is recognized as an inevitable accident.

The video of this simulation you can find on this link: https://youtu.be/xBM5CcjKb8I




## 4. Conclusions

"Delivery riders" is a very popular topic in Sri Lanka as well as in foreign countries. The quality of this field, which is renewed day by day, can take their organizations to the top in terms of business. The most important thing for any organization is to provide superior and quality service to its clients. Any organization should be ready for this. Especially for organizations that work with "delivery riders", the main person in contact with customers is the motorcycle riders. Therefore, the quality of the service received by them always reflects the quality of the company. Therefore, this system can be used to filter decent motorcyclists. This system can completely stop drunk driving. Then those organizations can give assurance of quality service to customers. And this can ensure that the employees' physical health is also taken care of. This enables the organization to ensure the safety of its employees while recruiting them. In the event of an accident, it is possible to minimize the damage caused by the accident and to respond quickly, because the seat is identified immediately.

It is expected to remove the GSM module and the GPS module to reduce the cost to produce this system commercially and get the facility through smartphones. It can save considerable cost and limit the finish, weight, and size of the system. Then commercially this can be used as a successful design.

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# AiCamView: An AI based Object Identification and Detection Mobile Application for Users with Dyslexia and Object Agnosia

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## Abstract

Powerful tools such as Artificial Intelligence (AI) and Machine Learning (ML) have taken over not only the software industry but also other industries these past few years. It is clearly evident that there has been a significant rise in AI and ML-based mobile applications and software systems catering towards abled individuals who possess a well-functioning cognitive process and are physically healthy. This has resulted in differently-abled individuals who struggle with certain disabilities and disorders being left out of the equation of having useful applications specifically developed in a way that is user-friendly for their needs as well.

Therefore, to deal with the significant issue of the lack of useful applications for these differently-abled users and the lack of mainstream applications being less user-friendly to them in general, this project aims to develop a fully functional AI and ML-based mobile application that is extremely user-friendly and accessible for individuals struggling with “Object Agnosia” and “Dyslexia” at the Global Brain Foundation (GBF). The application is named ‘AiCamView’ and will be developed using the Java language in the Android Studio IDE. The key functions of this app include Object Identification, Text Detection, Text Translation and Text-to-Speech are provided for them. In order to provide these functions to users, APIs and tools such as Google Cloud Vision API, Basic v2 edition of the Google Cloud Translation API, Google ML kit, Text-to-Speech by Android Studio, Volley HTTP library and other contributing technologies were used. The completion of this project resulted in a highly functional application consisting of all the planned app functions so that users with Object Agnosia and Dyslexia can be assisted easily. In conclusion, in-depth research, designing the app based on the needs of the user given from the survey, development based on those designs, and thoroughly testing this project application resulted in it being successfully completed within the intended timeframe.

The overall structure of this project paper will showcase the complete process of research done through a literature review and technologies and tools, a background of the app, functional and non-functional requirements, research approach and data collection method used, project management, design, implementation, testing, and the final results of the application.

**Keywords:** Object Agnosia, Dyslexia, Artificial Intelligence (AI), Machine Learning (ML), Application Programming Interfaces (APIs), Text Detection, Text Translation, Object Identification, Text-to-Speech (TTS), ML kit, Java, Android Studio, Global Brain Foundation (GBF)

**Extended Abstract**

## 1. Introduction

Artificial Intelligence (AI) and Machine Learning (ML) have had quite a significant impact on software applications and due to that, it has been a popular field of study and interest within the software industry, having taken root and successfully expanded itself towards other industries as well. It **is said that 91.5% of major businesses** make an investment in Artificial Intelligence on a continuous basis (Watters, 2023).

With that being said, we as an advanced society live and function in a highly technological era, in which abled individuals have a range of exceptional applications (both mobile and web) to pick from to make their chaotic lives much easier, whereas, differently-abled people, specifically individuals who struggle with Dyslexia and Object Agnosia have few options due to the software industry having limited applications cater towards them. Even with all the limitless technology in the palm of our hands, it is said that 98% of the top one million in the world do not have a completely accessible experience for people with a learning disability or visual impairment (Flink, 2022).

Object Agnosia is widely known as a disorder in which an individual is unable to identify or recognize objects they see, despite normal vision and sensory functions. There are times where familiar objects and other belongings are unrecognizable. They struggle to differentiate between objects that are quite alike or struggle in recognizing an object from a different angle. This disorder arises due to the damage to particular regions of the individual's brain that is responsible for object recognitions and visual processing, such as the temporal and occipital lobes. According to statistics, it is said that less than 1% of all the neurological patients possess Agnosia (Physiopedia).

Dyslexia is a learning disability/disorder that is primarily associated with difficulties in reading. Individuals who are Dyslexic struggle with accurate recognition of words, poor spelling, reading comprehension, and ability of recalling words swiftly. Dyslexia is widely believed to possess a neurological and genetic basis, which involves differences in the way a Dyslexic person's brain would process and interpret the language. It is stated that, 1 out of 10 individuals struggle with Dyslexia, therefore, with the world having a population of approximately 7.8 billion people, there will be 780 million individuals who are Dyslexic. This would mean that 10% of the existing world population have Dyslexia. Furthermore, a substantial proportion of approximately 15% to 20% showcase a learning disability focused on language, with Dyslexia being the prevailing impairment. This would signify that one in every five students is affected by a language-based learning disability, with Dyslexia standing out as the primary condition within this category (Zauderer, 2022).

In order to better safeguard and assist individuals struggling with these two neurological conditions, an organization named Global Brain Foundation (GBF) come into play. The GBF have dedicated their time and effort towards the health and overall well-being of people who not only struggle with Object Agnosia and Dyslexia, but also several other neurological conditions and brain diseases that are rare. GBF have many branches in different countries around the world, including Sri Lanka. Just as the GBF members in other countries, people in Sri Lanka who have Object Agnosia and Dyslexia are registered under the GBF as a community to gain assistance and support from them. The GBF is widely known for frequently

voicing out their concerns and one such concern happens to be the prevalent issue of differently-abled people who struggle with Dyslexia and Object Agnosia.

## 2. Methodology

The Quantitative research approach was the only research approach used for this project to effectively collect data and conduct an analysis on the gathered data results. This particular research approach involves the systematic collection and analysis of numerical data. It enables the identification of patterns, averages, prediction-making, testing cause-and-effect relationships, and generalizing findings to larger populations. In contrast to qualitative research, which focuses on non-numerical data, quantitative research relies on numerical information for its investigations (Bhandari, 2020).

The reason why I selected to perform only the Quantitative approach was because it allowed me to identify certain patterns, make solid predictions based on the data gathered from the respondents' feedback, analyse them accordingly, and draw valid conclusions from it.

As mentioned before, to justify the aim of the project, the data collection method used was an Online survey done on Google forms and then it was analysed as a whole on Google sheets. After using the Quantitative approach, the only limitation that I experience was that it does not fully capture the range of factors which influence the topic that is being studied.

## 3. Results and Discussion

The following images showcase the responses regarding the AiCamView application that was gathered from the online Google form survey that was sent via a link to differently-abled individuals (with Dyslexia and Object Agnosia) and their family members and friends. I total of 52 people completed the survey.

The form includes a description as to what and why data is being collected, including app installation instructions for the user.

"AiCamView" - An app for Individuals struggling with Visual Agnosia and Dyslexia

Two brain disorders; one that is common and the other quite rare. **Visual Agnosia**, a rare disorder that mainly affects how the brain processes objects. Despite having perfectly functioning senses, they would not be able to identify objects visually presented to them. **Dyslexia**, a common learning-based disorder affecting an individual's ability to spell, read, speak, and write.

This form aims to obtain informative feedback from users regarding ***An AI and ML based Object Identifying, Text Detecting, Text Translating, and Text-to-Speech (Audio) converting mobile application for Users struggling with Dyslexia and Object Agnosia*** named "***AiCamView***".

**App Installation Instructions:**

1. Visit the Link provided to you
2. Download the AiCamView APK file to your mobile phone
3. Click on the downloaded APK file and Install the AiCamView application
4. Once the downloading process has finished, click on the app and start using it

*Figure 1 - Online Survey: Introduction*

Question 1 shows the age range of the respondents, in which the age range of 26 to 30 holds the highest percentage of 34.6%, followed by the second highest at a percentage of 30.8% being between 22 to 25. Adults over 31 stands at a percentage of 26.9%. Finally, teenagers and young adults between 19 to 21 are at 7.7%.

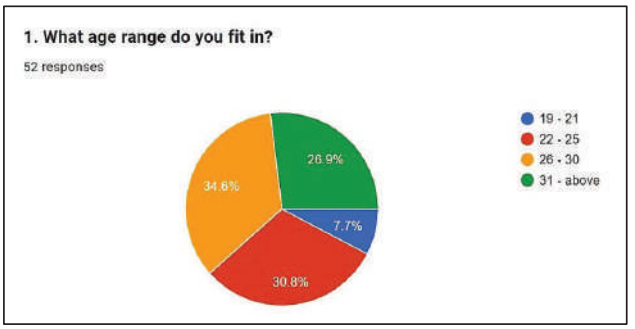



*Figure 2 - Online Survey: Question 1*

Question 2 asks how many respondents filling the form are differently-abled and a majority of 71.2% say they are, while 28.8% say they are not.

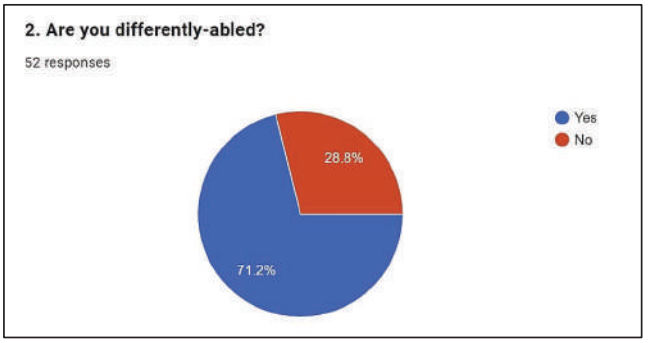



*Figure 3 - Online Survey: Question 2*

Question 3 asks the respondents whether they have object Agnosia or Dyslexia and majority of them (42.3%) say they have Dyslexia and this is because Dyslexia is a common neurological condition when compared to Object Agnosia. Since the family members and friends of the differently-abled individuals filled the form as well, the second highest at 26.9% were respondents who know someone who has one or both of those conditions. The third highest is 17.3% who are the individuals with Object Agnosia. The least high at 13.5% are individuals who struggle with both of those conditions.

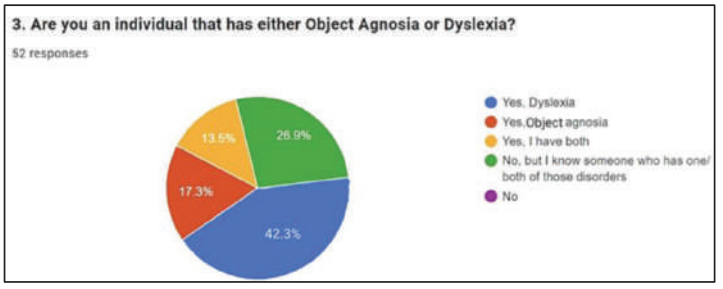



*Figure 4 - Online Survey: Question 3*

Question 4, seeks to know the knowledge of the respondents regarding AI and ML, in which majority of them at 67.3% say they only know about AI since it happens to be the most popular technology in use today, while second highest at 26.9% know both AI and ML. The least at 5.8% said they only know about ML.

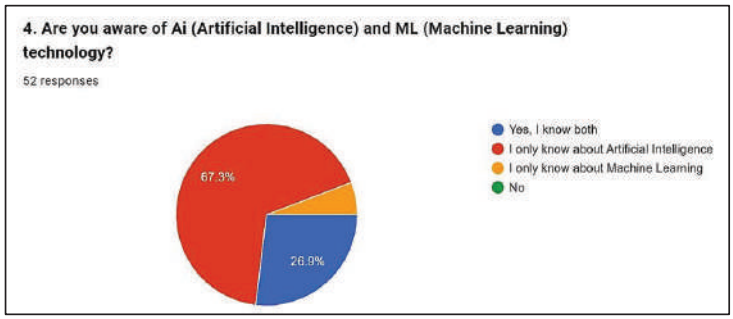



*Figure 5 - Online Survey: Question 4*

When asked what the respondents think about the app, the responses provided in Question 5 basically compliment the overall app, especially, the Text and translation feature, audio feature, UI, as well as the Object identification feature. Some say the app is good and more feature can be added to make it even better.

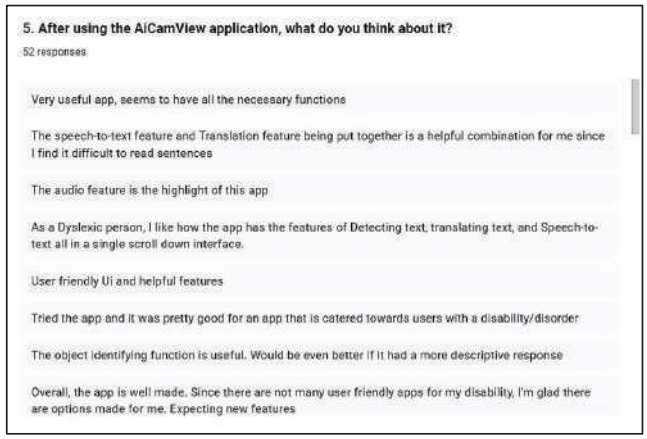



*Figure 6 - Online Survey: Question 5*

In Question 6, 96.2% of the respondents said they think the app has all the required functions, while 3.8% say the app does not have it all.

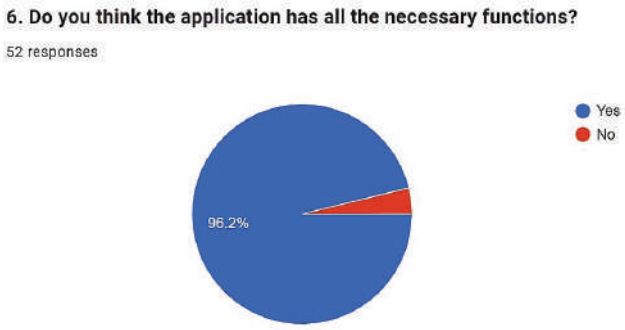



*Figure 7 - Online Survey: Question 6*

Question 7 asks the respondents if the user interface is according to their liking and all of them say they do since it was made to be user-friendly.

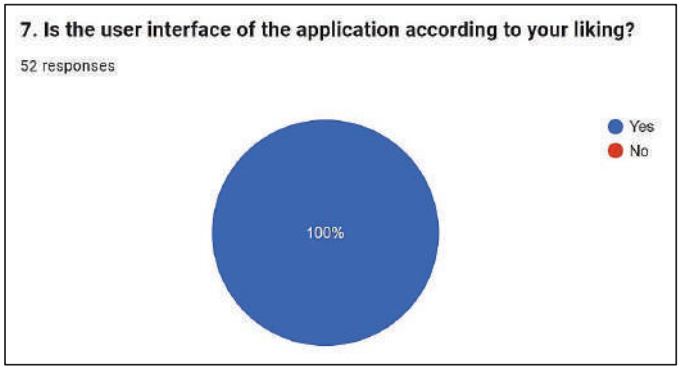



*Figure 8 - Online Survey: Question 7*

Question 8 asks whether the app lacks anything and 92.3% of them said No, while the rest of the 7.7% were unsure about it and said maybe.

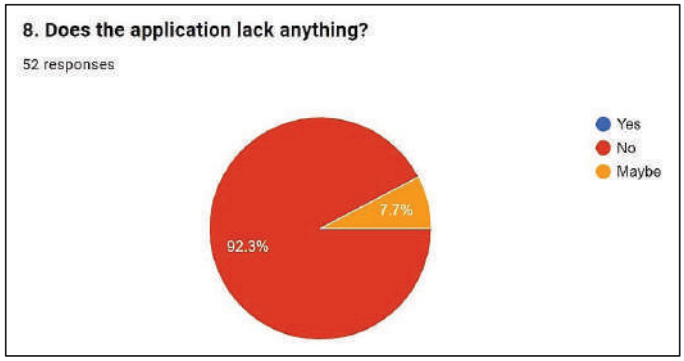



*Figure 9 - Online Survey: Question 8*

Question 9 asks whether the app is user-friendly and all of them said Yes.

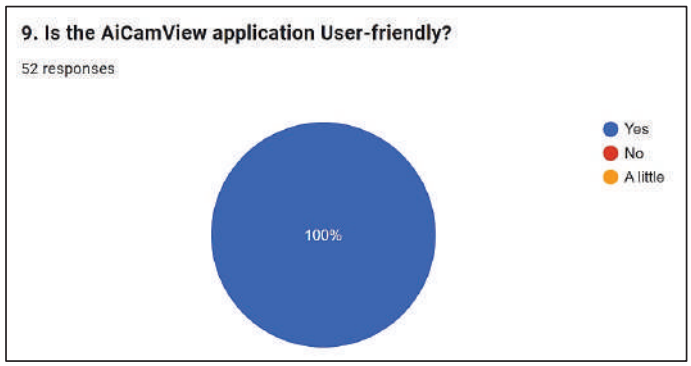



*Figure 10 - Online Survey: Question 9*

Question 10 asks whether they would recommend this app to individuals with Object Agnosia and Dyslexia and all of them said Yes.

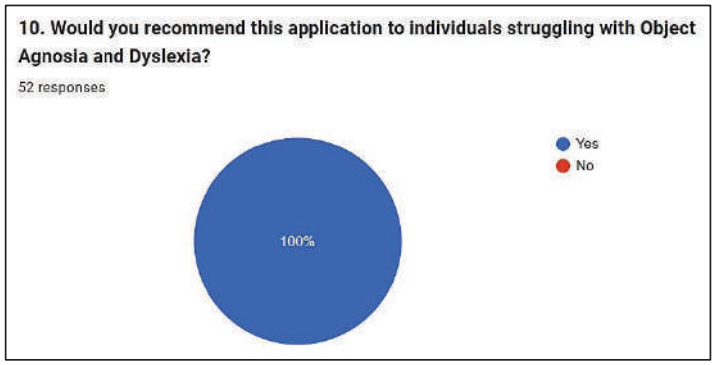



*Figure 11 - Online Survey: Question 10*

Question 11 asks whether there are any other apps similar to AiCamView and majority (73.1%) of them said no because the app has its own unique set of functions, while the rest of them (26.9%) said maybe. Even if they chose maybe, they say the app is specifically made for the needs of differently-abled users with dyslexia and object agnosia.

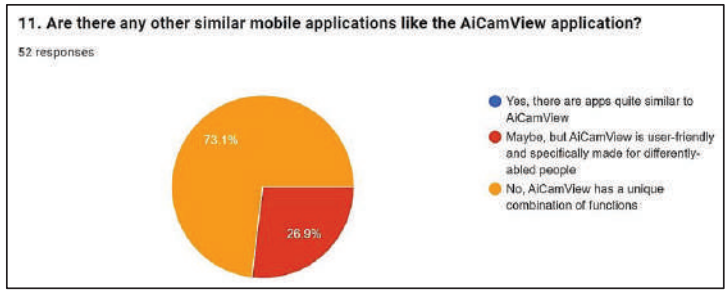



*Figure 12 - Online Survey: Question 11*

Question 12 asks the respondents to rate the AiCamView app on a rate of 1 to 10 and 20 respondents (38.5%) gave a full score of 10, while another 20 (38.5%) gave a score of 9. 10 respondents (19.2%) gave a score of 8, while a score 7 was given by 2 people (3.8%)

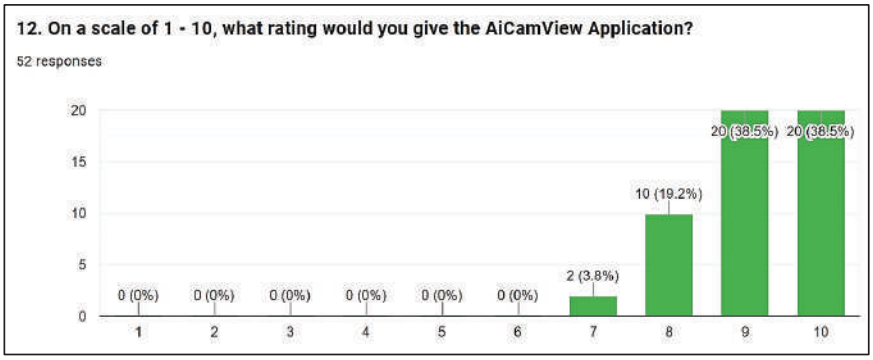
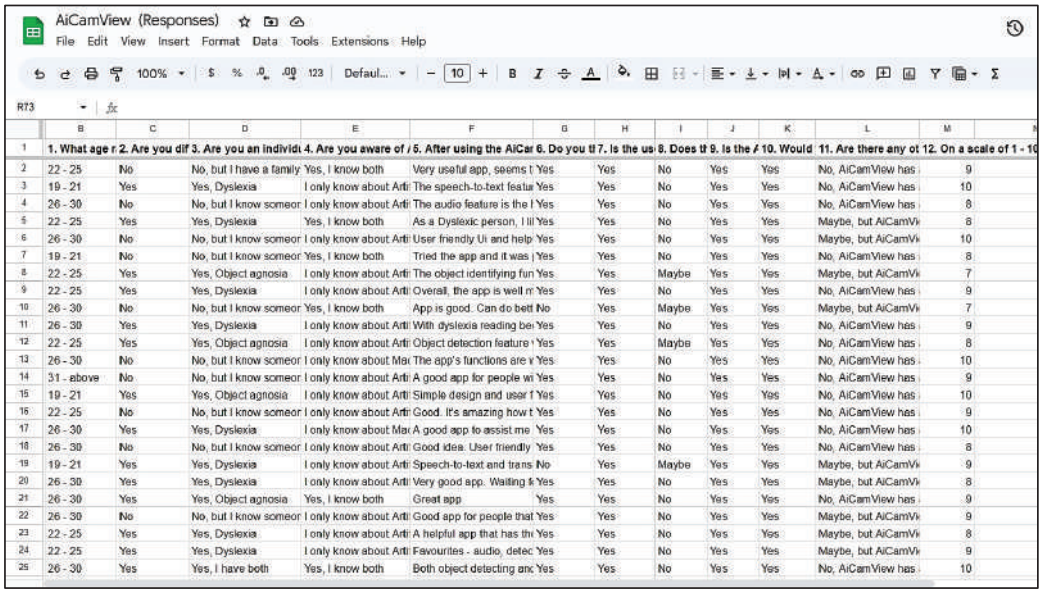



*Figure 13 - Online Survey: Question 12*

All of the responses gathered from the respondents were deeply analysed using Google Sheets. Therefore, I was not only able to get a pie chart view of the responses but also a detailed view in Google sheets as well.

*Figure 14 - Online Survey: Spreadsheet View*




| | B | C | D | E | F | G | H | I | J | K | L | M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1. What age r | 2. Are you dif | 3. Are you an individi | 4. Are you aware of / | 5. After using the AiCar | 6. Do you th | 7. Is the us | 8. Does th | 9. Is the A | 10. Would | 11. Are there any ot | 12. On a scale of 1 - 10 |
| 2 | 22 - 25 | No | No, but I have a family | Yes, I know both | Very useful app, seems t | Yes | Yes | No | Yes | Yes | No, AiCamView has | 9 |
| 3 | 19 - 21 | Yes | Yes, Dyslexia | I only know about Arti | The speech-to-text featu | Yes | Yes | No | Yes | Yes | No, AiCamView has | 10 |
| 4 | 26 - 30 | No | No, but I know someor | I only know about Arti | The audio feature is the I | Yes | Yes | No | Yes | Yes | No, AiCamView has | 8 |
| 5 | 22 - 25 | Yes | Yes, Dyslexia | Yes, I know both | As a Dyslexic person, I lil | Yes | Yes | No | Yes | Yes | Maybe, but AiCamVi | 8 |
| 6 | 26 - 30 | No | No, but I know someor | I only know about Arti | User friendly Ui and help | Yes | Yes | No | Yes | Yes | Maybe, but AiCamVi | 10 |
| 7 | 19 - 21 | No | No, but I know someor | Yes, I know both | Tried the app and it was | Yes | Yes | No | Yes | Yes | No, AiCamView has | 8 |
| 8 | 22 - 25 | Yes | Yes, Object agnosia | I only know about Arti | The object identifying fun | Yes | Yes | Maybe | Yes | Yes | Maybe, but AiCamVi | 7 |
| 9 | 22 - 25 | Yes | Yes, Dyslexia | I only know about Arti | Overall, the app is well m | Yes | Yes | No | Yes | Yes | No, AiCamView has | 9 |
| 10 | 26 - 30 | No | No, but I know someor | Yes, I know both | App is good. Can do bett | No | Yes | Maybe | Yes | Yes | Maybe, but AiCamVi | 7 |
| 11 | 26 - 30 | Yes | Yes, Dyslexia | I only know about Arti | With dyslexia reading be | Yes | Yes | No | Yes | Yes | No, AiCamView has | 9 |
| 12 | 22 - 25 | Yes | Yes, Object agnosia | I only know about Arti | Object detection feature | Yes | Yes | Maybe | Yes | Yes | No, AiCamView has | 8 |
| 13 | 26 - 30 | No | No, but I know someor | I only know about Mac | The app's functions are v | Yes | Yes | No | Yes | Yes | No, AiCamView has | 10 |
| 14 | 31 - above | No | No, but I know someor | I only know about Arti | A good app for people wi | Yes | Yes | No | Yes | Yes | No, AiCamView has | 9 |
| 15 | 19 - 21 | Yes | Yes, Object agnosia | I only know about Arti | Simple design and user f | Yes | Yes | No | Yes | Yes | No, AiCamView has | 10 |
| 16 | 22 - 25 | No | No, but I know someor | I only know about Arti | Good. It's amazing how t | Yes | Yes | No | Yes | Yes | No, AiCamView has | 9 |
| 17 | 26 - 30 | Yes | Yes, Dyslexia | I only know about Mac | A good app to assist me | Yes | Yes | No | Yes | Yes | No, AiCamView has | 10 |
| 18 | 26 - 30 | No | No, but I know someor | I only know about Arti | Good idea. User friendly | Yes | Yes | No | Yes | Yes | No, AiCamView has | 8 |
| 19 | 19 - 21 | Yes | Yes, Dyslexia | I only know about Arti | Speech-to-text and trans | No | Yes | Maybe | Yes | Yes | Maybe, but AiCamVi | 9 |
| 20 | 26 - 30 | Yes | Yes, Dyslexia | I only know about Arti | Very good app. Waiting fo | Yes | Yes | No | Yes | Yes | Maybe, but AiCamVi | 8 |
| 21 | 26 - 30 | Yes | Yes, Object agnosia | Yes, I know both | Great app | Yes | Yes | No | Yes | Yes | No, AiCamView has | 9 |
| 22 | 26 - 30 | No | No, but I know someor | I only know about Arti | Good app for people that | Yes | Yes | No | Yes | Yes | Maybe, but AiCamVi | 9 |
| 23 | 22 - 25 | Yes | Yes, Dyslexia | I only know about Arti | A helpful app that has the | Yes | Yes | No | Yes | Yes | Maybe, but AiCamVi | 8 |
| 24 | 22 - 25 | Yes | Yes, Dyslexia | I only know about Arti | Favourites - audio, detec | Yes | Yes | No | Yes | Yes | Maybe, but AiCamVi | 9 |
| 25 | 26 - 30 | Yes | Yes, I have both | Yes, I know both | Both object detecting and | Yes | Yes | No | Yes | Yes | No, AiCamView has | 10 |

## Conclusions

The research problem addressed in this academic paper is the lack of applications and resources designed for individuals with Object Agnosia and Dyslexia at the GBF, as well as the limited accessibility and user-friendliness of mainstream applications. The contribution to the problem arises from the specificity and complexity of these neurological conditions, the limited market demand for specialized applications, and the lack of understanding and awareness among developers and the software industry.

To address this problem, the proposed solution was the development of a fully-functional, user-friendly, and accessible mobile application named 'AiCamView'. This application utilizes AI, ML, and other tools and technologies to provide useful functions that contribute to simplify their daily life include object identification, text detection, text translation, and text-to-speech (audio) conversion functionalities. The application was designed to cater specifically to the needs of individuals with Dyslexia and Object Agnosia, offering a simple user interface and customizable language options.

The project app was specifically formed to cater to the needs of users who experience this problem with the help of well-thought-out and selected technologies, tools, use of testing frameworks to ensure reliability, use of appropriate functional and non-functional requirements, etc. In addition to that, it also adheres to data protection regulations to ensure the user's privacy, purpose limitation, and user's having control over their data. When the app was tested among individuals with Dyslexia and Object Agnosia at the Sri Lankan branch of the GBF, it was found to have made their time-consuming tasks much easier.

As for the answers for the project's research questions confirmed the fulfilment of the aim and objectives of this project. Therefore, the app was successfully developed to detect text, identify objects, translate both detected text and object name, and provide audio output. The users are able to select their preferred language for translation and listen to the audio results as well.
In conclusion, the development of the AiCamView application successfully addressed the research problem by providing a user-friendly and accessible solution for individuals with Dyslexia and Object Agnosia. The research process involved careful planning, implementation, testing, and evaluation, adhering to professional, ethical, and legal considerations. The app shows great potential in improving the daily lives of individuals with these conditions and can serve as a valuable resource in the field of assistive technology.

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# Network QoS Monitoring System

**M.R.H.M. Aathiff [1], Anis Saboordeen[2]**

*[1]Solent University, United Kingdom.*
*[2]British College of Applied Studies, Sri Lanka.*

## Abstract

The "QoS Monitoring System" project aims to develop a real-time network Quality of Service (QoS) monitoring and management system. It will comprehensively assess network performance by monitoring metrics such as bandwidth, throughput, latency, jitter, and data transfer rate. This system, accessible via a web-based dashboard, offers innovative solutions to optimize QoS, ensuring a consistent user experience.

## Extended Abstract

### 1. Introduction

Technology and innovation is important nowadays, where network performance is a key factor. There are many websites and software to monitor the network quality based on speed and latency. But according to the networking theories, to understand the full quality and to effectively manage our networks we need bandwidth, latency along with data transfer rate and packet delay variation.

Therefore, I decided to create a website, which can capture network Quality of Service (QoS) aspects in real time for users to give understanding about their networks. The website will assess network performance by monitoring bandwidth, latency, jitter, and throughput. This website will be accessible through a user-friendly web-based dashboard for the users.

This "QoS Monitoring System" project is more useful for the network administrators because it provides real-time insights to understand QoS. Furthermore, monitoring solution will elevate user satisfaction and system reliability. This project serves a practical purpose apart from displaying QoS metrics, it helps in understanding the network performance and importance of the network management.

As conclusion, this project uses data capturing methods to monitor network performance, including additional metrics like variation in packet delay and data transfer rate, which are mostly missed to capture in existing solutions. Also, it offers a user-friendly dashboard accessible via a website, enhancing the accessibility and usability of the system.

## 2. Methodology

This project relies on both quantitative and qualitative approach. Where the qualitative method helps to gather and analyze numerical data related to network QoS. While quantitative method helps to measure the impact of the network metrics and user satisfaction.

Qualitative Research
This qualitative research is conducted based on the following academic questions,

*Question-1: "How does understanding Networking QoS help optimize the network?"*
If the developed system was able to capture network QoS, it will provide insights regarding the condition of the networks. Where this knowledge can be used to optimize a network in ways such as choosing the suitable ISP provider, prioritizing critical traffic, allocating bandwidth efficiently, reduce latency, and improve reliability. Also QoS helps optimizing the network's performance while potentially saving costs on infrastructure upgrades.

*Question-2: "What is the correlation between data transfer rate, packet delay variation, and user satisfaction?"*
If my project is success then I can come to a conclusion that, higher data transfer rates and low jitter leads to increased user satisfaction as high speeds enable fast and smooth experience for users.
As a conclusion of qualitative research, this project helps the users to take decision as follows,

- It helps users choose the best internet service provider by providing insights on bandwidth, latency, jitter, and throughput.
- It helps to identify network issues quickly for faster solution.
- It helps users to save cost for unnecessary bandwidth extensions.
- It facilitates insights for data-driven decisions regarding network upgrades and improvements.

Quantitative Research
Likewise, the quantitative research was done by conducting a survey with the people I know to gather information on the impact of the network metrics and user satisfaction., which includes google forms to gather information and use that information to analyze my project.

## 3. Results and Discussion

The Network QoS Monitoring Website is a user-friendlier website for capturing and visualizing the QoS information on a specific network connection.

Tools and techniques

1. **Frontend and Backend Development:** The project includes frontend (HTML, CSS, JavaScript) for user interface and backend (Node.js with possible Python integration) for data processing and management. Adaptations may occur to align with future needs. I will follow scrum-based agile methodology for flexibility and responsiveness.
2. **Online Hosting:** I will host the website online with some free hosting to ensure availability for user.
3. **Network QoS Capture:** Upon accessing the website, users will encounter "Start" button. Clicking this button will trigger the website to initiate QoS data capture from the network. This real-time data collection will be performed in the background. I'll be using some free servers for this capturing process (google drive, Mega, Dropbox).
4. **Data Visualization:** The captured QoS data will be presented to users through a visual dashboard which will be developed with CSS and JavaScript.
5. **IDE:** to develop the website I'll be using Visual Studio Code.

Data Collection

**Table 01**. How each QoS metrics will be collected.

| Data | How it will be collected |
|---|---|
| **Bandwidth** | Sending packets back and forth to the users and measure how fast the internet connection can do this. |
| **Latency** | measuring the milliseconds it takes for data to travel from the device to the website and then back to device. |
| **Jitter** | measuring the variation in round-trip times. |
| **Throughput** | measuring the rate which data is transmitted from the device to the website. |

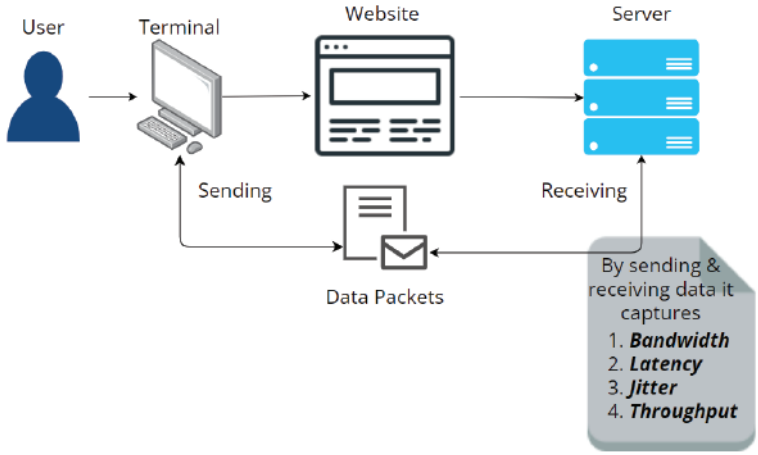


*Figure 1:workflow*

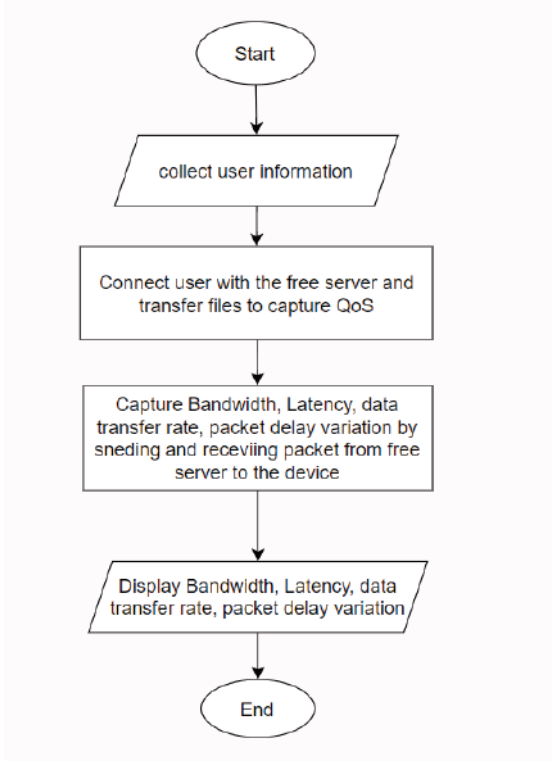


*Figure 2:flowchart*

*Figure 3:Wireframe-homepage*

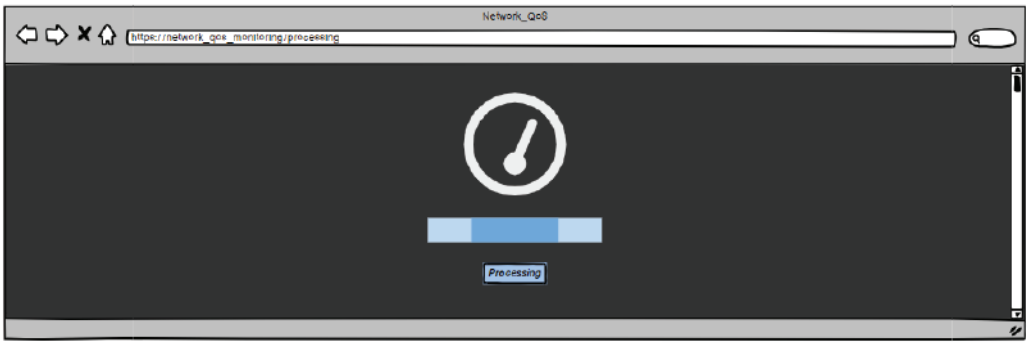


*Figure 4:Wireframe-process-page*

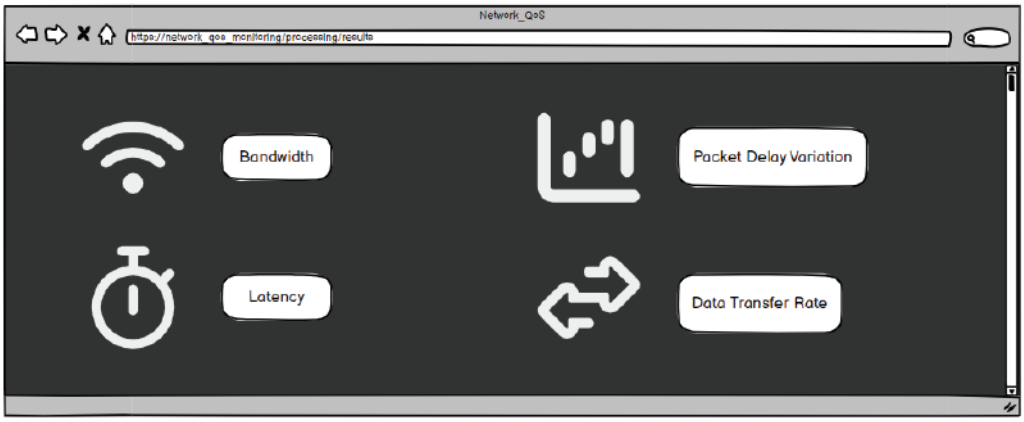


*Figure 5:Wireframe-Results-Page*

The website will be capturing QoS by transferring data packets between the server and device.

Development methodology

Scrum-based agile method is used for Its iterative and incremental approach aligns perfectly with the creation of web development, highlighting frequent testing to changing requirements, like evolving frameworks, services, and dashboard requirements. This allows for adaptability and continuous improvement throughout the project. Since I lack knowledge in coding. Therefore, this method was useful to check each functions were working correctly after it has been implemented. If any changes were required I was able to go back and do the changes accordingly.

## 4. Conclusions

It's important to understand that the details which are given in this proposal are based on initial assumptions, since the project is not being started yet. The scope and methodologies will remain the same, but other things such as different frameworks, services, or dashboard design may include some different from this proposal as needed. The agile methodology which has been decided to use will assist changes as the project progress. I can ensure that the end results will align closer to the proposal which is made above.

Overall, this project will deliver an easy to use, simple, flexible and capturing tool for both technical and non-technical users to monitor and understand their network performance in detail. Furthermore, I'm well prepared to adapt to any changes or requirements to provide a high quality solution, with proper project management. All the tasks, changes will be documented in the logbook to ensure reliability.

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# THE IMPACT OF DIGITAL TRANSFORMATION ON LOW-CARBON DEVELOPMENT OF MANUFACTURING SECTOR IN WESTERN PROVINCE SRI LANKA.

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## Abstract

This research delves into the dynamic growth of the manufacturing industry in Sri Lanka's Western Province, examining its historical, financial, and cultural influences. It explores how the sector has evolved from traditional beginnings to a center for export-oriented enterprises, contending with contemporary challenges related to environmental sustainability. The study focuses on the impact of digital transformation, encompassing advanced technologies like IoT, AI, and automation, on the industry's low-carbon development. Through comprehensive data collection and analysis, the research evaluates the level of digitalization in manufacturing, measures reductions in greenhouse gas emissions, and assesses the environmental and economic implications. Ultimately, it aims to advance sustainable practices and enhance the region's global competitiveness.

## Extended Abstract

### 1. Introduction

The Western Province of Sri Lanka has witnessed significant growth in its manufacturing industry, influenced by a complex interplay of historical, financial, and cultural factors. From its origins in traditional industries to its development during British rule and subsequent post-independence strategies, the region has evolved into a hub for export-oriented enterprises, embracing advanced technologies while grappling with conservation and globalization challenges (Wijesingha). The manufacturing sector in this province plays a pivotal role in the local economy, contributing to GDP, employment generation, and export earnings, thereby serving as a driving force for economic growth.

However, the manufacturing industry in the Western Province faces a range of environmental challenges that profoundly impact the sustainability of the region. Issues such as carbon emissions, resource utilization, waste generation, air quality, water pollution, habitat disruption, and noise pollution pose significant threats to the environment and overall sustainability. In response to these challenges, the manufacturing industry has been increasingly adopting environmentally friendly practices, cleaner technologies, improved waste management, and enhanced energy efficiency. Moreover, government incentives and regulations play a crucial role in promoting environmentally responsible behavior among businesses and mitigating the environmental impact of the manufacturing sector in the Western Province.

The research problem at the core of this study pertains to the sustainability challenges faced by the industrial sector in the Western Province, primarily linked to carbon emissions, resource utilization, and waste production. The environmental impact and carbon footprint of the region are directly affected by these challenges. In the context of digital transformation, which integrates cutting-edge technologies such as IoT, AI, and automation, manufacturing

processes have the potential to undergo a significant revolution, offering opportunities to enhance industry productivity and competitiveness. However, there is a research gap in understanding how the utilization of digital technology in the industrial sector can effectively contribute to achieving low-carbon development goals. Specifically, there is a lack of knowledge regarding the extent to which the digital age can aid the Western Province's industry in reducing carbon emissions and advancing sustainability. This research seeks to address this gap and explore the potential of digital transformation to support not only environmental objectives but also the industry's overall sustainability.

The objectives of this study encompass evaluating the level of digitalization in manufacturing enterprises within the Western Province and quantifying the actual reduction in greenhouse gas emissions achieved through the adoption of digital technology. This entails measuring the amount of greenhouse gases released and removed, summarized via carbon footprint assessments and expressed in terms of CO2e or other relevant metrics. Such assessments are pivotal in helping businesses gauge their environmental impact and contribute to the global commitment to mitigating climate change.

The significance of this study lies in its alignment with global efforts to combat climate change. By focusing on the potential of digital transformation to reduce industrial emissions, particularly carbon dioxide, this research directly contributes to the broader goal of curbing greenhouse gas emissions, which are major contributors to global warming and its associated climate effects. Additionally, the adoption of digital technologies in the manufacturing sector can lead to improved product quality, lower production costs, increased production speed, and expanded market reach. This, in turn, bolsters the competitiveness of manufacturing businesses in the Western Province and fosters innovation, creating a conducive environment for startups, researchers, and entrepreneurs. Ultimately, this research aims to position the Western Province's manufacturing industry as a global player, enhancing sustainability, economic growth, and competitiveness on the world stage.

## 2. Methodology

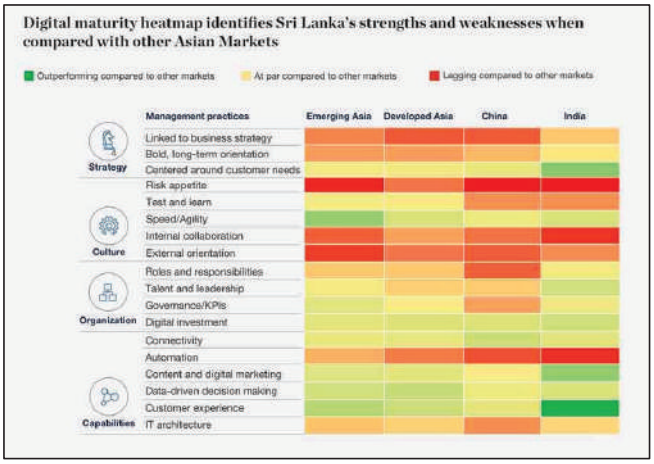
The goal of the research technique used for this study is to fully investigate how the industrial sector in Sri Lanka's Western Province would benefit from low-carbon growth. It includes procedures for collecting information, analyzing that data, and a suitable conceptual structure.This study's research design is set apart by a mixed-methods strategy that blends both qualitative and quantitative methods of research. This strategy was chosen to guarantee an in-depth investigation of the study issue and to provide a greater comprehension of the complex links involving technological change and low-carbon growth.Transmission of structured surveys to manufacturers operating in the Western Province will be a part of this research project. These surveys will be made to collect quantitative information on the scope and kind of activities for digital transformation within the industry. (Dasanayaka, 2022)

The effect on industrial processes, technology adoption, and investments in digital infrastructure are only a few examples of possible questions.A theoretical structure combining ideas from numerous pertinent theories and models will serve as the research's direction. These include sustainability frameworks to evaluate the effects on the environment, the Resource-Based Perspective (RBV) to comprehend resource management, and the hypothesis of innovation diffusion to investigate technological uptake.The research attempts to provide a thorough analysis of how technology affects low-carbon growth in the industrial sector in the Western Province employing a mixed-methods methodology and theoretical framework. The study looks for to offer practical insights and policy suggestions to improve sustainability in manufacturing operations by integrating quantitative and qualitative data. (Sovacool, 2023).

## 3. Results and Discussion

The research is centered on two methods. first is focused on the fundamental study. The fundamental study examines the GSCM techniques now in use in Sri Lankan supply chain operations for the manufacture of apparel. This answers the basic concern of the viability of the GSCM practices that are being used. The application of these GSCM practices to SME Clothes Company in Sri Lanka is examined in the second phase of the project, which is applied research.

A general framework is then constructed, providing a series of the most useful techniques for adapting old SC to GSC for operational processes in Sri Lankan garment manufacturing (Liyanaarachchi)companies. The research adopts a scientific methodology. To find out if existing GSCM practices have a beneficial or detrimental effect on organization performance, it evaluates the relationship between such practices and performance. A correlational research technique is going to be used. (htt48) Many Sri Lankan businesses have strong long-term digital plans, but their aims and objectives can be more effectively merged across the company and into the company's overall strategy, Ninety percent (90%)of the businesses questioned felt that just a small portion of possibilities is being addressed by their digital activities. These businesses frequently take part in various digital efforts, but they hardly ever connect them to one another or the overall business plan. (htt49)



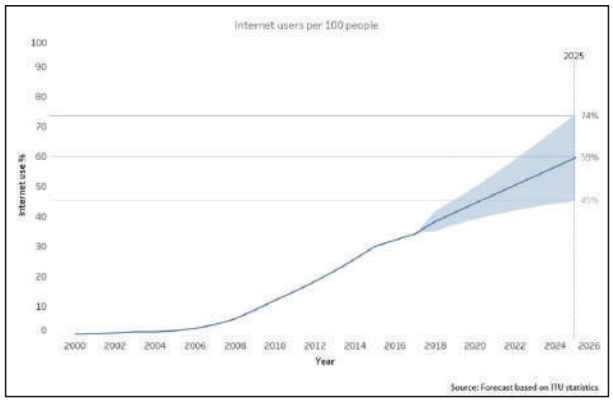

Only 30% of businesses think that their digital strategy addresses the most pressing issues or is determined by customer demands and expectations.

The quick-moving and innovative nature of digital technology is well-suited to the cultures of many Sri Lankan businesses.

Organizations have created cross-functional agile groups and are actively looking for purchase and partnership possibilities from the outside to aid in the development of their digital capabilities.

The ability of businesses to innovate and keep up with an ever-shifting marketplace is, however, limited by the relative lack of test-and-learn practices (a technique for quickly testing

new ideas with a small number of locations or clients based on a fail-fast outlook and accelerated avenues to proof of concepts). Only 8% of the organizations that were surveyed have used a test-and-learn technique.




There is currently not a method that can be used globally to estimate the amount of the online component of an economy. The absence of industry and product categories for the "Digital Economy" and "Digital Sector," as well as the lack of a universally agreed definition of The measurement of the digital economy is hampered by the web and related services.Still, there are several workarounds. They are all reliant on how Digital is used.It defines the economy. Numerous activities, encompassing nearly the whole economy, have been transformed by digitization.A broad definition of the "Digital Economy" However, it is more practical than measuring efforts on a particular sector of economic activity given the fundamentals of digitalization.If the phrase "Digital Sector" suggests certain restrictions on economic activities, the phraseThe term "digital economy" is frequently used to describe an industry where digitalization includes all economic sectors, from warehousing to agriculture.Research currently available indicates that most nations' digital sectors are still less than10% when additional value, income, or employment are taken into account. (htt60)

According to a 2018 IMF staff report, the next five elements are the most evident in every digital economy. These five elements together indicate the scale of the digital economy.

o Online platforms, including e-commerce platforms; o Platform-enabled services o ICT equipment, semiconductors sector, Telecommunication and Internet access services; o Data processing, software, and other information services.

The above method was used to determine the extent of the digital economy in Sri Lanka because it is simple and simple to understand. The indicated sizes of each component and their related values in relation to GDP . (htt50)

**Conclusions**

In today's world, the effect of digital transformation on low-carbon growth in the manufacturing sector of Sri Lanka's Western Province is a topic of rising importance. We will discuss the main conclusions and consequences of our study in this conclusion, including the possible advantages, difficulties, and chances for long-term industrial development in the area. Positive effects on sustainability and efficiency: In Western Province, the manufacturing industry has experienced a digital revolution that has resulted in substantial improvements in sustainability, resource efficiency, and efficiency. Technology advancements in technology, data analytics, and the Internet of Things (IoT) have allowed businesses to streamline their manufacturing procedures, use less energy, and generate less waste. This supports the global effort to cut carbon emissions while also helping to save money.

Economic Development and Job The beginning: The Western Province has seen economic development as a result of the use of digital technology. Companies are able to grow their operations and, as a result, create new employment possibilities as they become increasingly competitive worldwide. This economic expansion may be used to fund other low-carbon projects, promoting a positive feedback loop for sustainable growth.

Barriers and problems: Whereas low-carbon development by digital transformation has essential promise, it is not without its barriers and problems. The initial cost of technology can be high, and a lot of small and medium-sized companies (SMEs) may find it difficult to budget for the required changes. To make sure an inclusive and secure transition, there are additional worries about information security, privacy of data, and the digital divide in the area. These issues need to be addressed.

Government and Stakeholder Participation: The Sri Lankan government, working with pertinent stakeholders, is essential in determining the course of digital transformation for low-carbon development. Rules, incentives, and policies should be created to promote innovation while promoting sustainable practices. Public-private collaborations can promote the sharing of information and funding for green technology.

Future Prospects, Digital technologies are expected to have an ever-growing impact on how the industrial industry develops in Western Province. Future advances that might improve sustainability include the incorporation of sources of clean energy, the creation of smart lines, and the use of artificial intelligence in supply chain management and predictive maintenance.

In conclusion, Sri Lanka's Western Province's industrial sector is experiencing a complicated and complex process as a result of digital transformation's effects on low-carbon growth. There are challenges to be overcome, but overall, the industrial environment is moving in the direction of becoming more sustainable and competitive. Western Province can continue on the road of low-carbon development and contribute to a greener and more successful future for the area as well as the globe with advance planning, purchases, and partnership between government, business, and civil society.

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# Harnessing Artificial Intelligence for Advance Agricultural Practices

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## Abstract

A major shift in the agriculture industry is about to occur, and it will be fueled by the incorporation of Artificial Intelligence (AI) technology. This article explores the enormous potential of AI in agriculture and offers a comprehensive framework for utilizing it to improve farming methods. The project, "Leveraging Artificial Intelligence for Advanced Agricultural Practices," aims to address the critical issues that contemporary agriculture is now facing, such as crop health monitoring, yield optimization, and sustainable resource management. A major shift in the agriculture industry is about to occur, and it will be fueled by the incorporation of Artificial Intelligence (AI) technology. This article explores the enormous potential of AI in agriculture and offers a comprehensive framework for utilizing it to improve farming methods. The project, "Leveraging Artificial Intelligence for Advanced Agricultural Practices," aims to address the critical issues that contemporary agriculture is now facing, such as crop health monitoring, yield optimization, and sustainable resource management. This project stands as a testament to the potential of AI in revolutionizing agriculture. By offering actionable insights and decision support to farmers, it sets the stage for advanced, sustainable, and data-driven farming practices. The article sheds light on the future of agriculture, where AI assumes a pivotal role in addressing the world's mounting food production challenges.

## Extended Abstract

### 1. Introduction

The integration of agriculture with artificial intelligence (AI) serves as a beacon of hope in a world where the demand for sustainable and effective food production is constantly expanding. Traditional farming methods, which are frequently characterized by arduous labor and unpredictability, are about to undergo a significant upheaval. This shift, which is being driven by the unrelenting advancement of AI technology, promises to transform how we plant, manage, and harvest our crops, the project at hand represents a paradigm change rather than merely an investigation.

In order to advance farming methods into a new era characterized by precision, sustainability, and data-informed decision-making, "AI-Powered Agriculture" aims to unlock the promise of AI. It has the potential of not only providing for the world's expanding population's nutritional demands, but also doing so in a way that preserves resources, lessens environmental impact, and increases agricultural yields.

Importantly, this initiative is supported by ethical, open, and responsible values. We solve privacy and bias issues, guaranteeing the safety of farmers' data and the impartiality of AI suggestions. We enable farmers to trust AI as a beneficial ally in their agricultural operations by providing them with clear and straightforward answers. Beyond maximizing crop yields, it encourages responsible resource management and places the environment at the center of all decisions.

## 2. Methodology

### 2.1. Research Methodology

The research methodology is a methodical procedure that includes identifying agricultural challenges, collecting data, choosing AI models, analyzing data, addressing ethical issues, offering clear justifications, emphasizing sustainability, rigorous testing, user training, and comprehensive project documentation. This methodical approach will direct the creation of an AI-driven agriculture system that places a focus on moral and environmentally friendly activities.

Examine in-depth the current studies, articles, and publications on precision farming, crop monitoring, yield prediction, and AI in agriculture. Examine the most recent innovations, plans, and recommended methods. AI Model Development For specific tasks like crop monitoring and production prediction, create new AI and machine learning models or alter current ones. Make sure the models can produce precise forecasts and are appropriate for the agricultural setting.

Systems Implementation Using the models you've created as a foundation, create a working AI-powered agricultural system. Integrate data sources, make sure the system is scalable and real-time capable, and design a user-friendly interface, assessment and testing Analyze the integrated system and the AI models in-depth.

In agricultural situations that actually exist, evaluate their application, accuracy, and efficacy. Analyze the collected data, including agricultural datasets and the results of the AI algorithms. To get insights and make judgments, use statistical tools and approaches for data visualization.

### 2.2. Development Methodology

Specifically created to accommodate the dynamism of agricultural AI systems, the agile development technique was used for this project. This approach places a strong emphasis on iterative development and continual improvement, which makes it easier to respond to altering user needs and changing agricultural environments. The performance of the system is eventually improved via frequent stakeholder input that is used to improve AI models and functionality. We guarantee that the system stays useful and effective in solving actual agricultural concerns by maintaining continuous contact with farmers and agricultural specialists. Our ability to create a resilient AI solution suited to the particular requirements of advanced agriculture methods is made possible by our adaptive and flexible approach.

#### 2.2.1. Project Planning:

The process of project planning entails identifying project objectives, assigning resources, and generating a thorough timetable. It is critical to the project's success. A well-defined project scope is critical because it establishes clear boundaries and goals. Stakeholder analysis aids in knowledge of all project participants. The work breakdown structure (WBS) hierarchically arranges tasks, making them easier to manage and allocate responsibilities. A project schedule specifies when tasks will be finished. The allocation of resources ensures that the appropriate persons and supplies are available. Risk assessment and budgeting aid in the management of unknowns and financial considerations. Effective

communication planning enables the flow of information among stakeholders. Processes for quality assurance and change management are critical for sustaining project quality and dealing with changes.

#### 2.2.2. Design and Prototyping:

The first important phase in advanced agriculture project planning is the design and prototyping of AI-driven solutions. This phase demands the development of algorithms and models that are suited to specific agricultural concerns such as crop management, insect control, and yield optimization. To achieve a complete AI system, the design process must include the integration of multiple data sources, ranging from soil quality and weather patterns to crop health parameters. Furthermore, prototyping enables the testing of AI-driven tools in a controlled setting before deploying them in the field, ensuring that they match the needs and expectations of farmers and agronomists.

#### 2.2.3. Development:

The project comes to life during the development stage for the AI-powered agriculture system. The development of software components, the integration of AI models, and the creation of data processing pipelines all take place at this stage. In order to provide a user-friendly experience, user interfaces are created and put into use. To ensure the system runs without a hitch, extensive testing and quality assurance procedures are used to spot and fix any software defects or problems. In order to produce a reliable and effective AI solution for advanced agricultural practices, the development phase is a dynamic and flexible process that lays the groundwork for the next phases of testing deployment and system assessment.

#### 2.2.4. Testing and Quality Assurance:

The creation of AI-powered agriculture solutions, the testing and quality assurance phase is critical. Extensive testing is required to ensure the correctness, dependability, and resilience of AI models. This entails evaluating their performance in a variety of environmental circumstances and datasets, imitating real-world settings. Quality assurance methods should be built to continually monitor and upgrade the AI system. In addition, including feedback from farmers and experts is critical in fine-tuning AI models to handle specific difficulties and enhance overall efficiency in agricultural project planning.

## 3. Results and Discussion

As of the time of this study, the Virtual Vogue project remains in its conceptual and developmental stages, yet significant insights have been garnered from the research methodologies and surveys conducted.

### 3.1. User Interest and Expectations:

Identifying and accommodating user interests and expectations is a critical component of AI project success. AI solutions may be created to meet the particular requirements and aspirations of the target audience by using a user-centered approach. This not only increases the AI application's relevance and engagement, but it also develops a sense of customization. Gathering user input on a regular basis and implementing it into project development ensures that the system improves in line with evolving user expectations.

Finally, achieving user expectations is not only a vital driver of user pleasure, but it is also critical for long-term involvement, assuring AI programs' sustained relevance and success.

### 3.2. Technical Feasibility:

The most important step in AI project planning is determining technological feasibility. It entails a detailed assessment of the existing technical infrastructure's capacity to support the planned AI deployment. This evaluation takes into account factors such as the availability of essential computational resources, data, and experience. Understanding the scalability needs of the project and maintaining compatibility with current systems are other critical concerns. Furthermore, recognizing possible technological risks and developing risk mitigation techniques are critical for effectively navigating any hurdles.

### 3.3. Ethical and Legal Implications:

AI agriculture faces challenges in terms of data quality and accessibility. The data used in AI models can often be fragmented, inconsistent, or limited, hindering the development of effective systems. Potential solutions include data augmentation techniques, such as remote sensing and IoT devices, to improve data quality and accessibility. Collaboration between governments, tech companies, and NGOs can also make AI tools more affordable and accessible to small-scale farmers, bridging the digital divide and increasing the adoption of AI in agriculture.

### 3.4. Challenges and Potential Solutions:

The ethical and legal dimensions of AI in agriculture are of paramount importance. Using AI for precision farming and data collection may raise concerns about data privacy and ownership. To mitigate these concerns, clear data ownership and privacy policies should be established. Moreover, AI's impact on sustainable farming practices and the use of pesticides and fertilizers requires a balance between maximizing yield and minimizing environmental harm. Policymakers and researchers should collaborate to develop guidelines and regulations that ensure responsible and sustainable AI-driven agricultural practices while complying with data protection laws to safeguard the rights of data contributors.

## Discussion:

The discussion regarding AI integration in agriculture is diverse, with huge consequences for the future of food production and sustainability. First and foremost, the use of AI in agriculture offers the potential to greatly increase production and efficiency. AI can help with agricultural management by forecasting disease outbreaks and even automating processes like watering and harvesting. These skills have the potential to not only boost yields but also to minimize resource use, making agriculture more ecologically sustainable. However, issues such as data access and the digital divide must be addressed to guarantee that the advantages of AI reach all farmers, regardless of their size or location.

Ethical issues are also included in the conversation. The application of AI in agriculture for data collecting and analysis necessitates careful consideration of privacy and data ownership. Farmers and landowners may be worried about who gets access to and uses their data. Transparent data ownership and privacy rules, as well as rigorous security measures, are required to build confidence and guarantee that data is used properly. Furthermore, the ethical issues of artificial intelligence in agriculture extend to sustainable practices. Finding the correct balance between increasing agricultural production and limiting

environmental damage is a difficult task. AI should be used to boost precision agriculture and resource management, with a focus on both production and environmental sustainability.

Consequently, data protection rules and regulations must be followed by AI in agriculture to prevent any legal repercussions. Handling sensitive agricultural data without legal authorization or in breach of data privacy rules might lead to serious consequences. A critical component of the debate is the creation of clear legal norms for AI data use and ethical behavior. Policymakers and industry stakeholders must collaborate to develop a legislative framework that promotes appropriate AI-driven agriculture practices while protecting data contributors' rights. To summarize, overcoming these complex ethical, legal, and technological obstacles while ensuring that the advantages of AI are accessible to all farmers and contribute to global food security and environmental sustainability is required for effective AI integration in agriculture.

## 4. Conclusions

In conclusion, the use of artificial intelligence in agriculture has enormous potential to transform the business, from crop management and resource efficiency to sustainability and food security. However, it is critical to acknowledge that this revolutionary potential is accompanied with a number of obstacles and obligations. To summarize, it is critical to address data quality, accessibility, and the digital divide in order to ensure that AI-driven solutions benefit all farmers, regardless of scale or location. Ethical factors such as data privacy and sustainable agriculture methods are critical to establishing confidence and ensuring that AI is used ethically. Legal compliance with data protection legislation is critical in order to avoid legal ramifications and preserve the rights of data providers.

Artificial intelligence in agriculture is a critical step toward a more efficient, sustainable, and ecologically responsible food production system. While problems remain, integrating AI technology offers the potential to address some of agriculture's most critical issues, such as climate change mitigation, resource efficiency, and enhanced crop management. The agriculture industry may leverage the potential of AI to secure long-term food security and sustainable practices by encouraging collaboration among stakeholders and enforcing ethical and legal norms, benefiting both farmers and the global population.

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# Empowering Healthcare: Development of A Virtual Assistant for Patient Care and Medical Support

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## Abstract

In the era of rapid technological advancement, the healthcare sector is undergoing a significant transformation, with a focus on leveraging AI and virtual assistance to enhance patient care. The increasing demand for innovative healthcare solutions has led to the development of virtual assistants designed to support both healthcare providers and patients. These virtual assistants offer a wide range of services, including patient monitoring, medication management, appointment scheduling, and symptom analysis. Their primary objective is to streamline healthcare processes and improve the quality of service.

Efficient integration into the healthcare system is crucial to empower healthcare providers further. By automating routine tasks, virtual assistants enable healthcare professionals to dedicate more time to complex patient care while providing personalized support to their patients. Key technologies driving the capabilities of virtual assistants include Machine Learning and Natural Language Processing (NLP). These technologies allow the virtual assistants to adapt to patients' needs and medical backgrounds, offering valuable and informative insights to both healthcare workers and patients.

The significance of this project lies in reducing the workload of healthcare professionals, minimizing the risk of errors, and enabling patients to manage their health more effectively. This, in turn, enhances healthcare accessibility and quality, ushering in a new era of patient-centric and technologically empowered healthcare solutions.

## Extended Abstract

### 1. Introduction

As we are currently living in the time of the advancement of technology one of the main sectors that are undergoing a huge shift is the health care sector in the capabilities of AI and virtual assistance which is done in order to boost the care of patients as the medical support by the need of increasing the need for innovative health care solutions.

There are virtual assistances and the objective of these assistances is that that it will be able to assist in the healthcare providers and as well as to the patients as well for instances there can be patient monitoring, medication management, appointment, the analysing of symptoms that the patient might have. It seeks the healthcare process and will be able to improve the service accordingly.

In addition to empowering healthcare there needs to be integration and efficiency where it can be designed to seamlessly integrate into the healthcare system. By the automation of the particular routine tasks the healthcare providers will be able to concentrate more on more difficult tasks of the patient care while they offer their personalized support to their patients.

Machine Learning and natural language processing (NLP) which is a field of Computer Science and AI play a key role when it comes to the virtual assistant's capabilities. The particular technologies will enable the assistant to adapt to the patients' needs and their medical backgrounds which in turn provide the health workers and the patients with insights that are valuable and informative.

The significance of this project is to mainly reduce the workload of the people who work in healthcare, to reduce any errors that might be there and as well as to help the patients to manage their health in a more effective manner. This will greatly help in healthcare accessibility and quality as well.

## 2. Methodology

When it comes to the integration of the AI in healthcare is able to offer tremendous potential for transforming the industry, but it also presents several significant challenges that must be addressed for its successful adoption. These challenges include:

1. **Training Requirements for Medical Professionals:** In order to make effective use of AI in healthcare, medical professionals need training to understand and utilize these technologies. This poses a considerable hurdle as many of them may lack the necessary technical skills. Furthermore, training must focus on how to integrate AI into their medical practices, enhancing their existing knowledge and skills.

2. **Data Privacy and Security**: AI relies on access to vast amounts of patient data, which raises concerns about safeguarding data privacy and security. It is crucial for healthcare providers to establish robust security measures to protect patient data from cyber threats and to ensure that patient privacy is always maintained.

## 3. Results and Discussion

The introduction of Virtual Health Assistants (VHAs) represents a significant advancement in the healthcare industry, bridging the gap between healthcare and technology. These AI-driven platforms function as personal medical advisors, available round the clock, to assist individuals in managing their health and navigating the complexities of healthcare systems. The surge in VHAs was particularly pronounced during the COVID-19 pandemic, providing a dependable alternative to traditional healthcare delivery models and online symptom searches. VHAs harness vast medical knowledge to offer accurate, personalized health information. Their impact extends beyond symptom checking, as they optimize patient engagement, reduce healthcare operational costs, and provide accessible healthcare information. By delivering tailored support, such as appointment reminders and contextual medical guidance, VHAs enhance the overall patient experience.

The introduction of VHAs in the healthcare landscape has several noteworthy implications. Firstly, the availability of 24/7 medical assistance through VHAs ensures that individuals can access healthcare information and support whenever they need it, reducing the burden on traditional healthcare facilities. This is particularly significant in times of crisis, as demonstrated during the COVID-19 pandemic, when healthcare systems were overwhelmed.

VHAs also play a crucial role in providing accurate and personalized health information. Their AI-driven algorithms analyze individual health data to offer insights and recommendations

specific to each user. This not only empowers individuals to make informed decisions about their health but also reduces the reliance on general online health searches, which can often be misleading or cause unnecessary anxiety.

Moreover, VHAs contribute to cost reduction in healthcare operations. By automating routine tasks, such as appointment reminders and basic medical inquiries, healthcare facilities can allocate their resources more efficiently. This not only leads to cost savings but also allows healthcare professionals to focus on more complex and critical aspects of patient care.

The transformation of healthcare delivery through VHAs has a profound impact on patient engagement and overall experience. By providing contextual medical guidance and personalized support, VHAs enhance the quality of care individuals receive. Patients feel more involved in their healthcare journey and have a reliable source of information and assistance. This, in turn, fosters a more positive and patient-centric healthcare environment.

## Conclusions

In conclusion, the integration of AI and virtual health assistants (VHAs) in the healthcare sector represents a significant advancement in the industry, offering numerous benefits to both healthcare providers and patients. As outlined in the introduction, these technologies aim to enhance patient care, reduce the workload of healthcare professionals, and improve healthcare accessibility and quality. VHAs leverage technologies such as machine learning and natural language processing to provide personalized support, monitor patients, manage medications, and offer valuable insights into patients' health.

The background section highlights the emergence of VHAs as a ground-breaking innovation at the intersection of healthcare and technology. They serve as personal medical advisors, available 24/7, to help individuals manage their health and navigate the complexities of healthcare systems. The COVID-19 pandemic has accelerated their adoption which has offered a reliable alternative to traditional healthcare models. VHAs optimize patient engagement, reduce operational costs, and provide accessible healthcare information, ultimately enhancing the overall patient experience.

The aims and objectives of developing VHAs are further outlined. The main aims include improving healthcare access, offering convenience, reducing healthcare costs, minimizing the transmission of infectious diseases, and facilitating data collection and analysis. These objectives aim to reduce healthcare costs, improve health and well-being, utilize technology effectively, and enhance employee productivity.

The methodology section discusses the challenges associated with implementing AI in healthcare, including the need for training medical professionals in AI technologies and addressing data privacy and security concerns. It is essential for the healthcare industry to overcome these challenges to fully harness the potential of AI and VHAs for the benefit of

patients and healthcare providers. This integration has the potential to revolutionize healthcare delivery, making it more efficient, accessible, and patient-centred.

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# AI-ENHANCED DOCUMENT SUMMARIZATION

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## Abstract

AI-enhanced document summarization is an innovative technology that leverages artificial intelligence to condense lengthy documents and articles into concise and coherent abstracts. Through advanced natural language processing and machine learning algorithms, this cutting-edge approach not only extracts key information and important insights from the source material but also ensures the summary maintains the original context and meaning. This transformative technology has the potential to significantly improve information retrieval, facilitating quicker decision-making and knowledge acquisition across various fields, from academia to business and beyond.

AI-enhanced document summarization represents a pivotal development in information processing, enabling the automation of time-consuming manual tasks and offering valuable applications in various domains. By harnessing the power of AI, it becomes possible to process vast amounts of textual data efficiently, providing users with concise and relevant summaries.

This not only accelerates research and data analysis but also enhances content accessibility for broader audiences, making it a pivotal tool for businesses, researchers, and educators alike. As the technology continues to evolve, its potential to transform how we consume and manage information becomes increasingly evident, promising a more streamlined and productive future for knowledge dissemination.

## Extended Abstract

### 1. Introduction

AI-enhanced document summarization is at the forefront of cutting-edge technology, revolutionizing the way we handle and consume vast amounts of textual information. In a world inundated with data, the ability to distill the most critical insights from extensive documents and articles has become paramount. With the emergence of artificial intelligence, we are witnessing a transformation in the way we extract, condense, and present information. This innovation empowers businesses, researchers, educators, and individuals to stay ahead in an information-driven landscape. Through advanced natural language processing and machine learning techniques, AI-enhanced document summarization offers an unprecedented solution for enhancing productivity and knowledge acquisition.

As AI continues to refine this technology, its potential applications are expanding across diverse sectors. From academia to business, journalism to legal documentation, and beyond, AI-enhanced summarization has the capacity to save time and resources while ensuring that essential information is not lost in the deluge of data. This introduction sets the stage for exploring the profound impact of AI-enhanced document summarization and how it is poised to reshape the way we interact with textual content, improving our ability to make informed decisions and fostering more efficient information retrieval and dissemination processes.

## 2. Methodology

### 2.1. Research Methodology

A research methodology is an ordered method or framework used in the research process. It includes the tactics and procedures used to collect, analyze, and interpret data in order to answer research questions or objectives. It usually comprises of a sequence of processes and procedures that lead researchers through the process of developing, carrying out, and verifying their investigations, assuring the validity and dependability of the results.

#### 2.1.1. Data Collection and Preprocessing:

The search process begins with the collecting of relevant materials in this early step. Web scraping, database retrieval, or manual selection of items based on certain criteria are frequently used. After gathering the documents, they are preprocessed, which involves activities such as text cleaning, tokenization, and the elimination of stop words and extraneous content. This stage guarantees that the text data is in a format that can be analyzed further.

#### 2.1.2. Text Representation and Feature Extraction:

The methodology's following section focuses on how document information is represented, and essential elements are retrieved for summarizing. Techniques such as TF-IDF (Term Frequency-Inverse Document Frequency), word embedding (e.g., Word2Vec or Glove), or more complex approaches such as BERT embedding may be used in this stage. The representation and feature extraction methods used have a considerable influence on the quality of the output summary.

#### 2.1.3 Text Representation and Feature Extraction:

The final phase is the creation and testing of the summarization model. This involves training a machine learning or deep learning model, which is frequently accomplished via the use of techniques such as extractive or abstractive summarization. Extractive models produce summaries by extracting sentences or phrases from the original material, whereas abstractive models generate summaries by rephrasing and paraphrasing the information. For supervised learning, the model is trained using a labeled dataset consisting of documents and matching human-generated summaries.

### 2.2. Development Methodology

A development methodology is a defined strategy or framework used in the design and management of software or technology projects. It describes the techniques, processes, and best practices for designing, developing, testing, and deploying software applications or systems. Development techniques serve as a road map for project teams, allowing them to cooperate quickly and deliver high-quality outcomes while following to certain rules, such as Agile, Waterfall, or DevOps, depending on the nature of the project and its needs. The development approach used is determined by factors such as project complexity, timing, and stakeholder requirements.

#### 2.2.1. Project Planning:

Project planning is the beginning phase in which the scope, objectives, and limitations of a software project are specified. It entails developing a roadmap that defines project objectives, deliverables, timetables, budgets, and resource allocation. This stage frequently includes recognizing possible hazards and establishing measures to reduce them. Effective project planning lays the groundwork for a successful development process by ensuring that everyone involved knows the project's scope and needs.

#### 2.2.2. Design and Prototyping:

The user interface (UI) for Virtual Vogue is rigorously built during this phase, with an emphasis on simplicity and user-friendliness. Interactive prototypes are built for user testing and input, and design adjustments are made iteratively depending on the feedback. Prototyping is widely used to graphically depict and test various software components, allowing stakeholders to provide feedback and help shape the design. This stage is crucial for ensuring that the program's user interface and capabilities match to the project's goals and demands.

#### 2.2.3. Development:

Developers focus on many essential components while creating AI-enhanced document summarization. They start by designing and fine-tuning the summarization method, making crucial decisions on the technique (extractive or abstractive) and the machine learning or deep learning models to use. The data pretreatment step is similarly important, requiring activities like as text cleaning, tokenization, and data curation to guarantee that the input data is ready. Front-end and back-end design efforts begin, with a concentrate on integrating critical features including product listing, virtual try-on capabilities, user registration, and login. To provide rapid development and a consistent user experience, modern web technologies and frameworks are used.

#### 2.2.4. Testing and Quality Assurance:

Testing and Quality Assurance in the context of AI document summarizing are key processes aimed at guaranteeing the correctness and dependability of AI-generated summaries. Robust testing techniques, including the use of assessment criteria such as ROUGE and BLEU, are used to compare the quality of produced summaries to human reference summaries. Validation datasets, which comprise a variety of documents and their associated human-generated summaries, are used to assess the AI model's performance. Testing also include fine-tuning and optimization in order to improve the quality of summaries. Human evaluators give crucial comments on topics like as relevance and coherence during user acceptability testing. Scalability and efficiency testing guarantee that the model can efficiently handle massive volumes of documents.

## 3. Results and Discussion

AI summarization, its generated summaries are presented and reviewed for quality and coherence. The debate critically reviews the model's performance, highlighting its strengths and opportunities for improvement. Furthermore, this phase investigates the practical consequences and significance of AI-generated summaries in attaining specific goals or use cases.

### 3.1. User Interest and Expectations:

In AI summarization, it is essential for recognizing user interest and expectations. Users' requirements range from swiftly obtaining vital information to comprehensive insights. To achieve these expectations, AI systems must find a balance. To guarantee that summarization models are in line with real-world needs, user input and preferences are used to steer their development. The Google Form questionnaires distributed among potential users have provided invaluable data regarding user expectations and concerns related to AI summarization.

### 3.2. Technical Feasibility:

Technical feasibility is critical. For proper summarization, complex algorithms, models, and natural language processing approaches must be used. It is critical for the actual deployment of AI summarization solutions to ensure that the selected technology is available, scalable, and efficient.

### 3.3. Ethical and Legal Implications:

Ethical considerations, including user privacy, data security, and algorithmic biases, have been thoroughly examined. Strategies to address these concerns, such as robust encryption methods, secure authentication techniques, and continuous algorithmic reviews, have been proposed. In AI summarization, ethical and legal issues are crucial. When handling sensitive or copyrighted material, legal regulations must be followed, and ethical considerations about privacy, prejudice, and openness must be addressed. It is critical for responsible AI summarization to ensure compliance with data protection rules and ethical principles.

### 3.4. Challenges and Potential Solutions:

The challenges of AI summarizing include preserving coherence in abstractive summarization and coping with different information. Discussions on these issues have resulted in the development of mitigating methods. Among the methods established to effectively handle these difficulties are regular hardware compatibility testing, user-centric UI/UX design, and backup plans for integrating with third parties.

## Discussion:

AI summarization is a significant improvement in natural language processing, with the potential to improve information retrieval and understanding. One significant topic of contention is the mix between extractive and abstractive summarization approaches. Extractive approaches, which pick and compress existing sentences, excel in preserving source text coherence but may fall short in terms of creativity. Abstractive approaches, on the other hand, provide more human-like summaries but frequently struggle with flow and factual correctness. Finding the appropriate balance in AI summarization is a constant issue, as engineers strive to offer summaries that are both helpful and natural sounding.

Ethical issues are equally significant in AI summarization talks. The use of artificial intelligence systems to summarize sensitive material, such as medical records or legal documents, raises concerns regarding privacy, confidentiality, and data security. Furthermore, the possibility of bias in language models may propagate prejudices and disinformation in summaries, necessitating the development of strategies to minimize such biases and assure responsible AI-driven summarizing.

The discussion encompasses the practical applications of AI summarization, spanning various industries such as journalism, finance, and content curation, the capacity of artificial intelligence to swiftly condense enormous amounts of information into succinct summaries has transformed news aggregation and tailored content distribution. It facilitates in the extraction of crucial insights from large reports and data sets in financial analysis. AI summarization has altered how we consume and handle information, and current conversations in this subject are examining methods to enhance and expand its capabilities for a wide range of applications.

## 4. Conclusions

In conclusion, AI summarization has emerged as a potent technique for rapidly condensing and extracting key information from large amounts of textual content. This technique has proven useful in a variety of sectors, such as news aggregation, content curation, and data analysis. Although great progress has been made in the creation of AI summarization models, difficulties like as preserving coherence and resolving ethical concerns remain key points for future research.

As AI summarization technology advances, its practical applications are projected to increase across sectors, assisting professionals and individuals in dealing with information overload. The ability of AI models such as BERT and GPT-3 to provide more contextually correct and coherent summaries suggests a bright future. However, ongoing research and development efforts are required to solve issues such as bias, data privacy, and fine-tuning summarization models for specific topics.

AI summarization is set to become an ever more fundamental part of everyday life in the next years, assisting in efficient information consumption and knowledge extraction. We could expect AI summarization to further alter how we handle and grasp the ever-increasing volume of textual data in our interconnected world by harnessing the capabilities of AI and natural language processing.

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# "MINING IN GREEN"

# SUSTAINABLE PRACTICES OF CARBON EMISSION IN CRYPTO MINING DATA CENTER OF THE BLOCK CHAIN INDUSTRY IN SRI LANKA

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## Abstract

Concerns regarding the environment have been raised as a result of the rapid expansion of blockchain technology and cryptocurrency mining, particularly in relation to energy use and carbon emissions. This study explores environmentally friendly mining processes in the cryptocurrency sector as well as sustainable solutions to these problems. A practical way to drastically cut the amount of carbon emissions produced by crypto mining operations is to switch to renewable energy sources like solar and wind power. The environmental impact of data centers can be significantly reduced by using renewable energy. The use of energy-efficient cooling systems provides a practical way to reduce energy usage in data centers. The best performance of mining equipment is guaranteed by proper cooling, which also helps to save energy and minimize emissions. A key factor in reducing power consumption is choosing and using energy-efficient mining hardware. Miners can increase productivity while reducing emissions by choosing hardware with high hash rates and low power consumption. Data centers used for crypto mining can use heat that has been recovered by integrating waste heat recovery devices. This reuse can involve heating neighboring structures or infrastructure, reducing overall energy use and emissions. Taking part in carbon offset programs has proven to be a successful tactic. Some cryptocurrency mining businesses make investments in projects that either lessen or seize carbon emissions produced outside of their activities, so becoming carbon neutral. The research presented here emphasizes how urgent it is for the bitcoin mining sector to adopt environmentally friendly procedures. It emphasizes how important industry-wide cooperation and public education are to establishing sustainable and ethical crypto mining operations.

**Extended Abstract**

## 1. Introduction

Many industries have adopted blockchain technology because it provides unmatched security, transparency, and efficiency. The environmental impact, particularly in the context of cryptocurrency mining, is one element that needs serious investigation. Concerns have been raised regarding how mining for cryptocurrencies, which is frequently powered by energy-intensive operations, contributes to carbon emissions and energy use.

The proof-of-work algorithm used by cryptocurrencies like Bitcoin and Ethereum leaves a large carbon footprint. According to studies, the combined worldwide carbon emissions from Bitcoin and Ethereum in 2017 were estimated to be at 43.9 million tons. This prompts questions regarding how blockchain technology affects greenhouse gas emissions.

The environmental effects of bitcoin mining have been reviewed in a recent report that was published in 2023. It raises the need to reconsider the effects of Bitcoin mining on the environment and emphasizes how it might help with the switch to renewable energy sources. The study emphasizes the significance of environmentally friendly methods in the mining of cryptocurrencies.

The spread of blockchain technology and cryptocurrency mining has an impact on the environment worldwide. However, due to Sri Lanka's distinctive geographical, economic, and environmental factors, it is crucial to personalize this research for Sri Lanka. Because Sri Lanka is a developing market for cryptocurrencies and blockchain technology, it's critical to consider how the expansion of this sector may affect the environment.

Right now, in Sri Lanka mining for blockchains and cryptocurrencies is still in its early stages in Sri Lanka. The sector is expanding as more people and companies look into the possibilities. The environmental concerns, however, have not been fully covered. This research is extremely important given Sri Lanka's dedication to sustainability and ongoing attempts to lower carbon emissions since it can help Sri Lanka to figure out the best practices at the early stages.

## 2. Methodology

To analyze solutions for the research I have used several methodologies such as conducting literature reviews, literature surveys, quantitative methods such as google form survey distributions to understand what the exact problem is and what is the possible solution for it.

**Conducting literature surveys:**

This **abstract** highlight the challenge of reducing greenhouse gas emissions (CO2) to combat global warming. It proposes an IT-based carbon sustainability framework for data centers, aiming to lower their carbon footprint. The framework leverages technology to maximize server use, introduces efficiency metrics, and promotes a sustainability strategy.

**Abstract Two** - This abstract discusses the increasing number of data centers due to rising demand for ICT applications, acknowledging the negative environmental impact of their carbon footprint. It focuses on assessing this impact, identifying emission factors, reviewing existing efforts to mitigate them, exploring sustainability metrics, and proposing strategies for making data centers more sustainable.

**Abstract Three** - The third abstract addresses the significant energy consumption of data centers and its environmental impact. It emphasizes the need to control power consumption without affecting operational efficiency. The research suggests that maintaining a high quality of Data Center operations and controlling power consumption is possible even with an increasing number of servers, resulting in savings and a reduced carbon footprint.

**Literature reviews:**
By conducting this literature review we analyses what are the main causes of carbon emissions and their impact of it in the data centers in general and in our topic, we found out how much intensive power does those data centers need to run and what are the proposed solution of them to lower the risk of carbon emissions and protect the environment. We also found out several ways in which we can lower the rate of carbon emissions, save the environment, and promote efficient ways to run the data centers and mine crypto are by Implementing energy efficient technologies, renewable energy sources, e-waste management, performance metrics, sustainable strategies and much more…

Once after completing the literature review, some of the other research methodologies which we used was providing feedback forms by creating through google forms and by having live discussions in class premises with other students. The google form falls under quantitative methodologies and in class discussions falls under qualitative methods. We gave each student one specific company to choose and analyze and then speak about the relevant topic regarding that company. This helped us to get more insights into what the solution really needed to be. Since we are focusing on Sri Lanka, currently crypto mining data centers are at its primary stages so by analyzing the faults in other countries, we can implement good practices of crypto mining in Sri Lanka from the beginning of their journey.

Survey feedback and discussion analysis: According to our research survey, we had many different opinions and insights about people votes and organization opinions, many of the current organizations have still not implemented carbon emission sustainable strategies for their data centers. Some of the solutions we have got to implement as a solution to this are listed down below:

- Implementing renewable energy sources
- Using carbon capture and storage technologies
- Following green building practices
- Better energy utilization and more efficient cooling systems to be implemented on the data centers.
- Implementing geographical location based suitable energy sources such as solar power for heated countries.

Even though these technologies exist in the current era, they have not been used by many organizations due to various reasons such as reliability issues, lack of knowledge in maintenance, and much more.

Down below is table depicted on how we are going to find proper strategies to implement these solutions to the customers and the global world.

**Table 01**. Scheduling.

| Task number | Task information | Estimated time plan (week) |
|---|---|---|
| 1 | Gathering resources information | 4 |
| 2 | Conducting a literature survey | 2 |
| 3 | Conducting a literature review | 1 |
| 4 | Creating and providing google forms for opinion gathering purposes | 4 |
| 5 | Scheduling in-class meetups with other colleagues to discuss further about this research | 1 |
| 6 | Solution assessment and final verdict | 2 |
| **Total time taken (estimated)** | | 14 |

## 3. Results and Discussion

In my research, I delved into the environmental implications of cryptocurrency mining within the blockchain industry in Sri Lanka. It's evident that the proof-of-work algorithm used by cryptocurrencies like Bitcoin and Ethereum contributes significantly to carbon emissions. The combined global emissions from these two cryptocurrencies in 2017 were astonishingly high, at 43.9 million tons. This brings up a critical concern about the impact of blockchain technology on greenhouse gas emissions.

The study underscores the pressing need for adopting eco-friendly practices in cryptocurrency mining. I've identified several solutions to mitigate carbon emissions, including harnessing renewable energy sources, implementing carbon capture and storage technologies, embracing green building practices, optimizing energy usage, and deploying more efficient cooling systems. Additionally, considering the geographical location, utilizing region-specific energy sources like solar power for warm climates could be beneficial.

I looked into how mining cryptocurrencies affected Sri Lanka's growing blockchain sector. The significance of using environmentally friendly mining techniques has been underscored by the study. The following suggestions have been made to reduce carbon emissions:

- **Adoption of Renewable Energy** - Using renewable energy for crypto mining activities, like solar or wind power, can greatly cut carbon emissions.
- **Energy-Efficient Cooling** - By installing more energy-efficient cooling systems in data centers, energy usage can be decreased, and environmental effects are reduced.
- Hardware optimization can increase productivity and save emissions by choosing mining equipment with high hash rates and minimal power consumption.
- **Waste Heat Recovery** - Waste heat recovery systems allow for the reuse of captured heat, which lowers overall energy use and emissions.
- **Carbon offset programs** - Companies that engage in cryptocurrency mining can become carbon neutral by investing in initiatives that lower or collect carbon emissions elsewhere.

**My proposed solution -** Public awareness and widespread industry change are crucial for ensuring the adoption of these eco-friendly techniques. My suggested course of action involves pushing for public awareness while guiding organizations that are resistant to change. This program intends to:

It's important to inform people about the effects crypto mining has on the environment and the existence of sustainable solutions. Campaigns to raise public awareness of the value of sustainable mining practices can educate people.

Companies that are reluctant to change can migrate to eco-friendly practices with the help of coaching and tools. Assistance with implementing energy-efficient technologies and renewable energy sources can be helpful.

## 4. Conclusions

My research concludes that the blockchain industry's expansion in Sri Lanka presents both promise and environmental challenges. As the nation is dedicated to sustainability and reducing carbon emissions, it's crucial to address these concerns. The identified solutions offer a pathway to achieve more eco-friendly mining practices, even though the adoption of these technologies has faced challenges.

This research emphasizes how important it is for Sri Lanka's blockchain business to adopt environmentally friendly mining techniques. The suggested fixes provide a means to dramatically cut carbon emissions. Their effective implementation, however, necessitates concerted efforts to increase public awareness and assist businesses in making the shift.

In conclusion, Sri Lanka's blockchain sector may reduce its carbon footprint and support a sustainable future by fusing environmental responsibility with public knowledge and support for industrial development. This strategy is in line with Sri Lanka's dedication to sustainability and can be used as a guide by other regions trying to deal with related difficulties in bitcoin mining.

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# Enhancing Threat Monitoring Security: Integrating Amazon Cognito B2C SSO for Seamless Authentication

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## Abstract

Organizations all over the world face enormous hurdles as a result of the frequency and sophistication of cybersecurity threats that are growing. This research suggests a novel strategy for improving threat monitoring security while delivering a seamless user authenticating experience in order to address these issues. The project investigates the integration of a threat monitoring application with Amazon Cognito's Business-to-Consumer (B2C) Single Sign-On (SSO) solution.

The study aims to respond to the following important research questions:

- How can the security of threat monitoring software be made more user-friendly?
- Can the B2C SSO integration from Amazon Cognito make the authentication process safer and easier to use?

This project contributes to the field of computer systems and networks by providing useful suggestions for enhancing system security while resolving issues with user authentication. The expected results include a thorough comprehension of the advantages and difficulties of the integrated solution as well as suggestions for boosting threat monitoring security.

This project seeks to increase security measures in the dynamic cybersecurity environment by bridging the gap between threat monitoring and user authentication.

## Extended Abstract

### 1. Introduction

An ever-expanding range of cybersecurity risks, from sophisticated malware and phishing attempts to data breaches and network flaws, characterize the modern digital landscape. Organizations in this dynamic environment have the daunting problem of protecting their digital assets and sensitive data while making sure that authorized users may access vital systems without experiencing undue difficulty. The demand for creative solutions that seamlessly integrate strong security measures with user-friendly authentication procedures has never been more acute as the relationship between security and user experience grows more and more crucial.

The goal of this research project, named "Enhancing Threat Monitoring Security: Integrating Amazon Cognito B2C SSO for Seamless Authentication," is to tackle this complex issue by investigating a cutting-edge strategy for securing threat monitoring apps. In particular, this project aims to integrate the Business-to-Consumer (B2C) Single Sign-On (SSO) solution from Amazon Cognito into an already-existing threat monitoring platform in order to improve security measures and provide a seamless authentication process for customers.

In today's digital world, when the quantity and complexity of cyber threats are constantly growing, threat monitoring software is essential. The danger of data breaches and other cyberattacks is reduced thanks to these software solutions, which enable firms to identify and respond to security threats in real time. attack analysis software, which uses sophisticated algorithms and machine learning techniques to find patterns and anomalies in network traffic that could signify a potential security attack, is one of the main components of threat monitoring software.

(Cybriant, 2023)

The effectiveness of threat monitoring programs, however, is inextricably linked to the effectiveness of its security controls, particularly with relation to user authentication. Traditional authentication techniques can cause friction, making it difficult for security experts to react quickly to possible threats. The growth of remote work and the demand for safe access from a variety of devices also highlight the significance of user authentication that is both secure and user-friendly.

Amazon Cognito provides a B2C SSO solution in response to these difficulties, promising to provide both strong security and a seamless user experience. The goal of incorporating this solution into a threat monitoring program is to enhance security precautions while retaining the speed and agility necessary for efficient threat response.

## 2. Methodology

The author describes a quantitative method for gathering and analyzing data. The technique is intended to evaluate the effects of threat monitoring security, user authentication effectiveness, and system performance on the integration of Amazon Cognito's B2C SSO.

1. Data Gathering:

a) Security Metrics:

Prior to and during the integration of Amazon Cognito's B2C SSO, the author intends to gather quantitative security data, such as the quantity of security incidents, the number of successful and unsuccessful login attempts, and the time it takes to detect and respond to threats.

b) Effective User Authentication:

The time it takes users to authenticate and access the threat monitoring application will be measured by the author.

c) Performance Standards:

By gathering quantifiable information on resource use (CPU, memory, network bandwidth), and reaction times during peak usage periods, the author will benchmark the system's performance.

2. Implementation & Integration:

a) Amazon Cognito integration:

To ensure compatibility and functionality preservation, the author will integrate Amazon Cognito's B2C SSO into the threat monitoring application.

b) Configuration:

Amazon Cognito will be set up to enforce security regulations including password rules and multifactor authentication (MFA).

3. Conclusion and Interpretation:

a) Results Interpretation:

To evaluate the effect of the Amazon Cognito B2C SSO integration on security, authentication effectiveness, and system performance, the author will analyze the quantitative findings.

b) Verdict:

On the success of the integration in boosting threat monitoring security and user authentication effectiveness, conclusions will be formed.

## 3. Results and Discussion

- By integrating the Business-to-Consumer (B2C) Single Sign-On (SSO) solution from Amazon Cognito, the project's main goal is to improve the security posture of threat monitoring applications.
- To Improve User Authentication: This project intends to offer security experts and authorized users accessing threat monitoring systems a user-friendly and effective authentication experience.
- To Close the Usability and Security Gap: This project aims to address the issue of matching strong security measures with a frictionless user experience within the context of threat monitoring by integrating Amazon Cognito's B2C SSO service.

## 4. Conclusions

In conclusion, this project represents an effort to broaden the toolkit available to security professionals, enable businesses to better safeguard their digital assets, and contribute to the conversation about user authentication, cybersecurity, and the fine line between security and user experience. The author is dedicated to exploring the potential of Amazon Cognito's B2C SSO solution in bolstering threat monitoring security as they set out on this journey of investigation, integration, and review.

The Business-to-Consumer (B2C) Single Sign-On (SSO) solution from Amazon Cognito has emerged as a beacon of hope, providing a way to reconcile security and user experience. Security experts will soon be able to maneuver their digital defenses with more efficiency and agility by easily integrating this solution into a threat monitoring application. Our quantitative evaluation of the effects of this integration, which is underpinned by thorough data gathering and analysis, strives to offer concrete proof of its effectiveness.

This study of threat monitoring demonstrates the revolutionary potential of creative thought and technical application.

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# MODEL SMART BUILDING OPERATION CONTROL SYSTEM "SMART-SKULL"

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## Abstract

In an era where technology continually reshapes our world, the concept of 'smart' has extended far beyond mere devices. It has woven itself into the very fabric of our environments, imbuing them with intelligence, responsiveness, and a touch of magic. At the forefront of this transformation is the Internet of Things (IoT), a revolutionary paradigm that empowers everyday objects to communicate, sense, and make decisions.

This assignment unveils a captivating vision of this potential through 'The Smart Skull,' a remarkable IoT model poised to revolutionize the concept of an office building. Inspired by its uncanny resemblance to human awareness, 'The Smart Skull' breathes life into spaces, rendering them not only efficient but sentient, where lights, sensors, and displays interact in harmony, seamlessly orchestrating a symphony of occupancy, comfort, safety, and sustainability. Join me as I delve into the intricate web of technology and imagination, exploring how 'The Smart Skull' shapes the future of office buildings and our very interaction with them.

## Extended Abstract

## 1. Introduction

The integration of Internet of Things (IoT) solutions has completely changed how buildings are maintained and run in the age of technological growth. This assignment introduces "The Smart Skull," a comprehensive Internet of Things (IoT) model that can be used to change a standard office building into a smart, effective, and user-responsive workspace. The name of the model itself denotes its capacity to mimic human vision and decision-making processes while accommodating many facets of building management.

"The Smart Skull" encompasses an array of sensors and actuators strategically placed throughout the office building. These components work collectively to monitor and enhance different aspects of the building's functionality. A motion sensor detects and analyzes human movement, enabling real-time occupancy monitoring of individual rooms. The data collected is displayed through a Liquid Crystal Display (LCD) screen, placed outside each room, informing occupants about room occupancy status. This facilitates effective space utilization and adherence to maximum occupancy guidelines.

Temperature sensors embedded within the model accurately gauge room temperatures, categorizing them as low, medium, or high through Light Emitting Diode (LED) indicators. This categorization empowers users to proactively manage room temperatures, preventing equipment overheating and promoting energy efficiency. Moreover, the model ensures room temperatures remain within optimal ranges by dynamically adjusting Air Conditioning (A/C) settings in response to LED indicators.

Safety is paramount in any building, and "The Smart Skull" is designed to enhance it. A gas sensor promptly detects gas leaks or smoke, triggering an alert mechanism through an integrated buzzer. This ensures rapid response to potential fire breakouts, safeguarding both occupants and infrastructure.

To address energy conservation concerns, the model employs a potentiometer to monitor and record the building's overall energy consumption. This data is then made accessible to relevant parties, enabling informed energy consumption planning and resource allocation

## 2. Methodology

The research methodology for this IoT model is underpinned by the quantitative research method, designed to provide precise, data-driven insights. It encompasses objective evaluation, enabling the accurate assessment of various parameters, such as room occupancy, temperature levels, and energy usage. Data collection is a continuous process, with sensors and equipment quantitatively measuring room conditions, including temperature and occupancy counts. To effectively present and interpret the quantitative data, the model leverages the data visualization capabilities of the Arduino IoT Cloud, creating visual representations through graphs, charts, and dashboards. This quantitative approach ensures a rigorous and objective evaluation of the IoT model's performance and functionality.

## 3. Results and Discussion

a) Overview Diagram

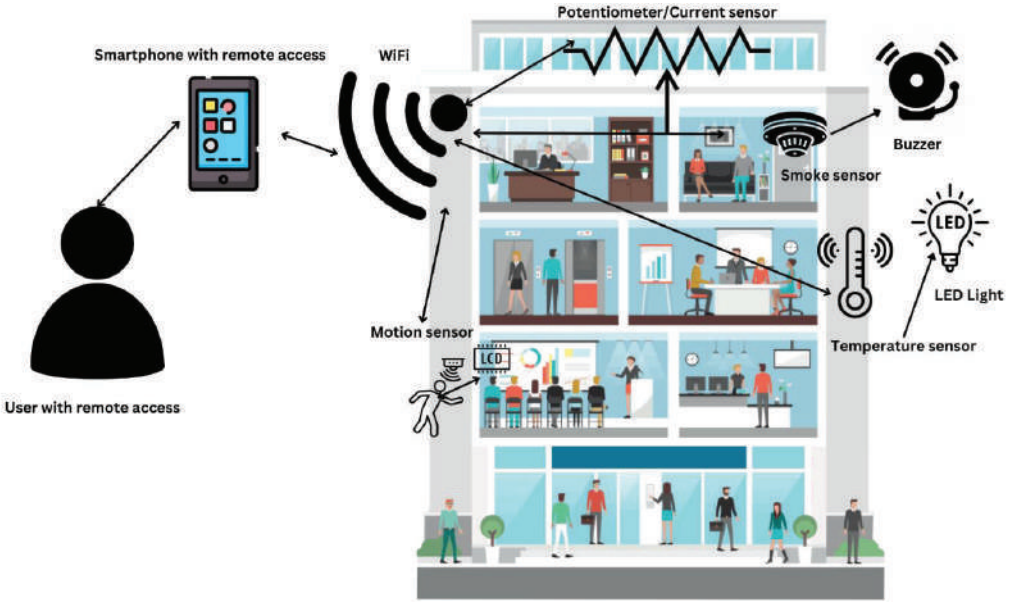


Figure 1 - Smart building operation control system overview diagram

b) Block Diagram

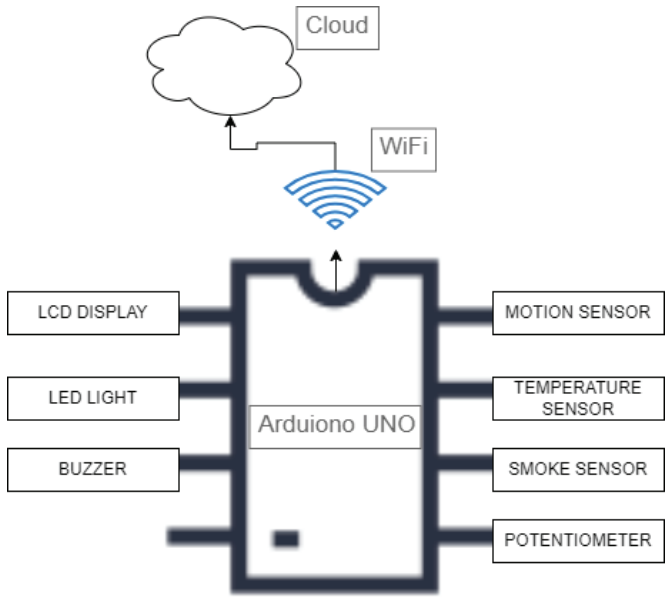


Figure 2 - Smart building operation control system block diagram

c) Flowchart

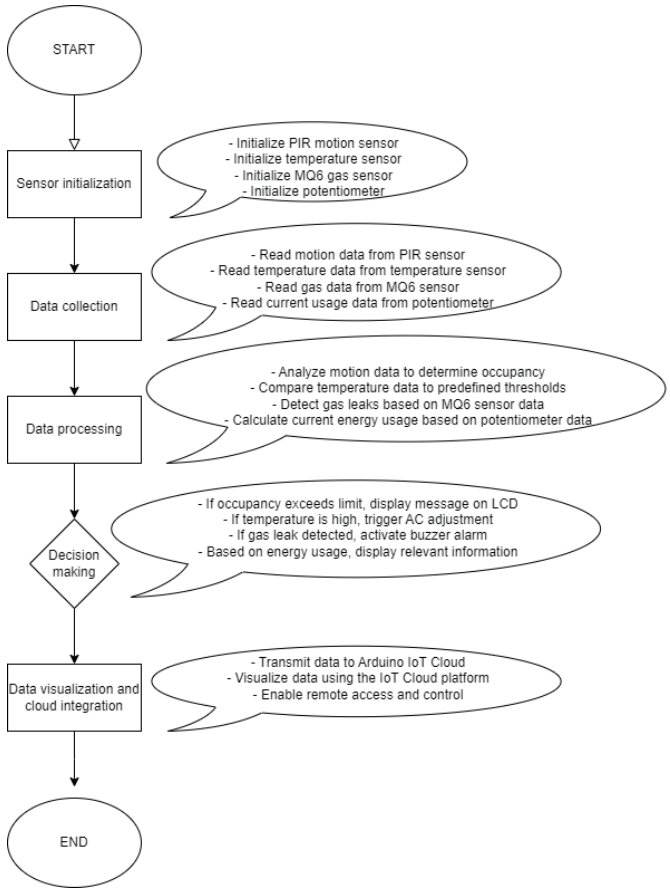


Figure 3 - Smart building operation control system flowchart

d) TinkerCad IOT model

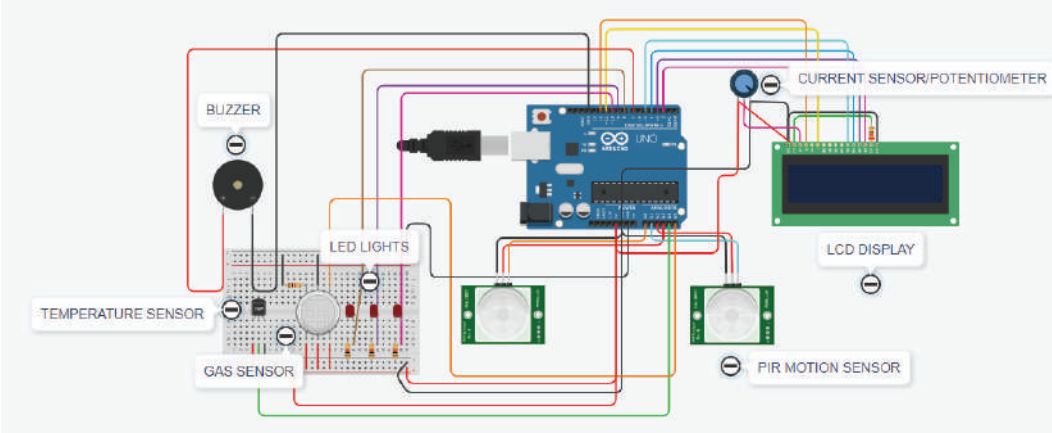


Figure 4 - Smart building operation control system model tinkercad

e) Fully implemented artefact model of SmartSkull

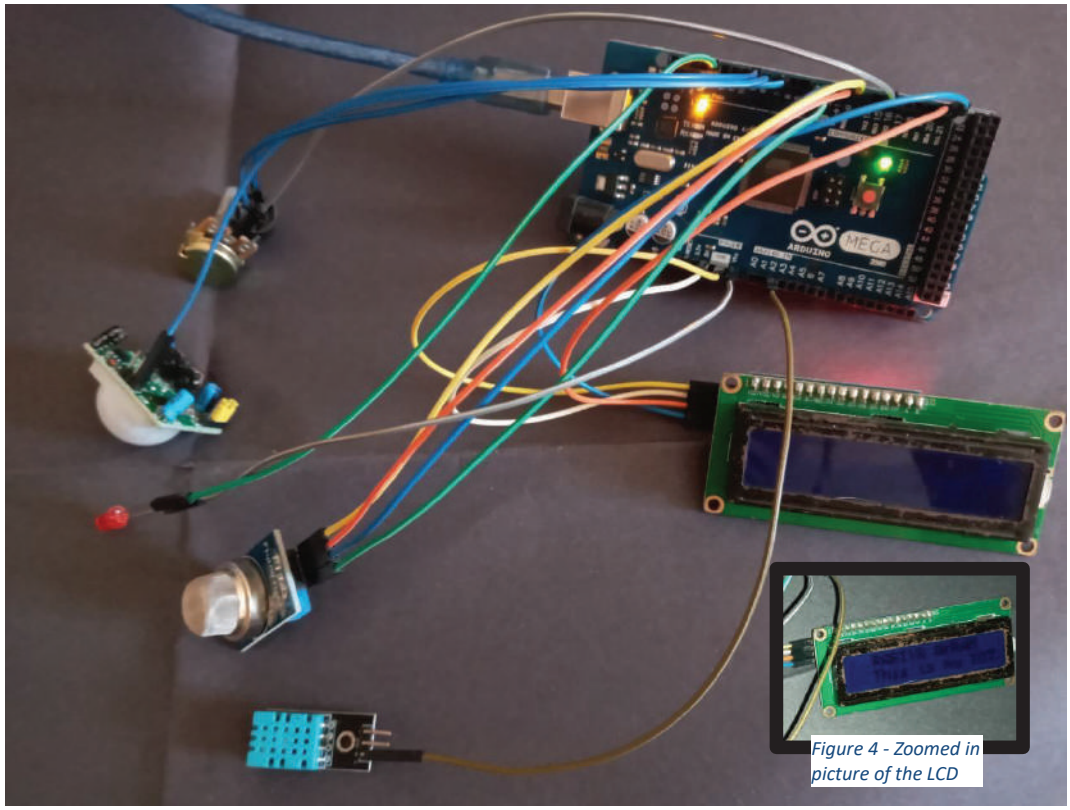


Figure 5 - My IOT artefact model

## 4. Conclusions

As we reflect on the journey that led to the creation of "The Smart Skull," it becomes evident that its design isn't just about technology; it's about enhancing the lives of those who inhabit the space. The marriage of PIR motion sensors, temperature sensors, gas detectors, and energy monitoring systems crafts a symphony of insight, ensuring that every corner of the building operates in harmony.

The user's experience is central to this creation. The LCD display, LED lights, and buzzer meld together to communicate with a human touch, making intricate data easily understandable and actionable. And with the power of WiFi connectivity and the Arduino IoT Cloud, control and management extend beyond the physical confines of the building, offering a sense of empowerment to those who govern its systems.

In a world where sustainability, efficiency, and intelligent living are paramount, "The Smart Skull" casts a radiant glow. It embodies a future where buildings are not just structures, but living entities that respond to the needs of their occupants. As we bid adieu to conventional paradigms, we usher in an era where the boundaries of innovation are constantly pushed, and "The Smart Skull" stands at the forefront, an emblem of limitless possibilities in the realm of IoT-powered smart spaces.

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# SMARTROLLY, THE SMART SEARCH BASED E-COMMERCE PLATFORM

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## Abstract

This study presents a comprehensive approach to enhancing the e-commerce user experience by incorporating cutting-edge technologies into the SmarTrolly platform. The project addresses a range of challenges, including unreliable product descriptions, difficulty in locating specific product versions, and concerns about product quality and authenticity. It proposes an advanced smart search system powered by natural language processing (NLP) to facilitate more intuitive and efficient product exploration. Additionally, a spam review detection system, utilizing deep learning techniques, is introduced to filter out misleading reviews and boost consumer trust. The study involves rigorous research methodologies, including data collection through surveys, user analytics, and sales data analysis, ensuring a data-driven approach. It further draws insights from existing solutions, such as Google's NLP-powered search and Amazon's advanced product search system, to inform the development of the SmarTrolly platform. Through these innovative solutions, the study aims to enhance user satisfaction, engagement, and conversion rates on the SmarTrolly, the e-commerce platform. The work represents a valuable contribution to the ongoing battle against review spam and offers a robust tool for improving the quality and reliability of product recommendations in e-commerce. It concludes with a summary of the Google survey results, highlighting the need for precise and transparent product information, multilingual support, and user-friendly features to enhance customer contentment and trust in e-commerce platforms.

## 1.Introduction

The success of e-commerce businesses depends on their ability to give users a pleasant shopping experience in a constantly changing digital environment. Every business's objective is to convert shoppers to paying customers. It has been a success till today but in order to expand it more and meet some common challenges, I have proposed a smart search system and spam review detection system in order to bring up a significant improvement in the important area and capture more customers. SmarTrolly website is a deep learning technology-powered e-commerce site with significant benefits for both for platform users and for platform organization.

Smart search system: smart search system is a feature that is an improved version of conventional search functionality on SmarTrolly by allowing end users to explore on products using natural language queries (the day-to-day way of human communication). The model understands and interprets user questions and requests in a way that is more similar to how man communicate and display results according to it. Natural Language Processing is a part of artificial intelligence that focuses on the interaction between computers and human language. This works with the incorporation of both semantic relations and mathematical models that scans stored products or products information similar to the user queries.

Spam consumer's review detection system: In an e-commerce platform, reliability and authenticity are crucial. Generally, customer reviews normally have a great impact on purchase decisions and higher conversional rates of end users. Implementing a review detection system reduces the likelihood of damaging customer's confidence to make purchase decisions on a product. With the use of deep learning concept, this system will spot and remove misleading reviews, allowing users to trust the input of their peers.

## 2.Methodology

The chosen methodology for this research project, which encompasses the development of a smart search system and spam review detection system for the SmarTrolly e-commerce platform, is driven by the need for rigorous data-driven insights and a structured approach to project management. In the context of enhancing user experiences in e-commerce, the methodology serves as the guiding framework for conducting surveys, gathering user analytics, and performing data analysis.

- **Quantitative Research:** To address critical research questions and objectives related to user preferences and requirements, it's essential to employ a quantitative research approach. This approach involves the collection and analysis of numerical data derived from surveys and user analytics.

- **Data Collection:** The research methodology emphasizes the collection of data from various sources to gain a holistic understanding of the e-commerce landscape. This includes using web surveys to gather user insights, web analytics tools such as SimilarWeb to assess user behavior on e-commerce platforms, and financial data from platforms like the Colombo Stock Exchange.

- **Statistical Data Collection:** One of the key aspects of the methodology is the deployment of surveys. Surveys serve as a valuable instrument for understanding user preferences, challenges, and satisfaction levels. This approach aligns with the project's aim to identify the specific demands and challenges faced by online shoppers. The data collected from surveys is essential for shaping the smart search system and spam review detection model.

### 2.1 Development Methodology

- **Scrum:** Scrum methodology is adopted for project development, with an emphasis on iterative progress and regular reviews. Weekly reviews with the project supervisor enable close monitoring of software development progress. This iterative approach supports the delivery of product increments within predefined timeframes, ensuring that the project stays on track.

- **Dataset Collection:** The project's success is highly reliant on the quality and diversity of datasets. For the smart search system, natural language query datasets are essential to train and refine the NLP models. For the spam review detection system, kaggle.com is identified as a potential source for obtaining relevant review datasets. These datasets, comprising both legitimate and fake reviews, are critical for training the spam detection model.

## 3.Results and Discussion

The results and discussion section of this research project provides an in-depth analysis of the findings and their implications. It encompasses the key outcomes derived from data collection, surveys, and the development of the SmarTrolly smart search system and spam review detection model.

### 3.1 User Insights and Preferences

The survey results reveal several valuable insights into user preferences and challenges in the context of e-commerce platforms. Respondents expressed a variety of challenges they encounter when shopping online. These include concerns about product descriptions, difficulties finding specific product versions, issues related to product quality and legitimacy, and problems with product sizing and language options. These insights underscore the importance of improving product information accuracy, product quality assurance, and user-friendly features like multilingual support and transparent pricing.

**Smart search model development:**

The SmarTrolly smart search system, which uses natural language queries, aims to address these user challenges. During the development process, natural language query datasets were collected to train the Natural Language Processing (NLP) model. The use of deep learning frameworks like TensorFlow allows the model to understand and respond to user queries more intuitively. The analysis of real-world search systems, including Google and Amazon, showed the effectiveness of incorporating NLP techniques for enhancing user experiences.

**Spam review detection model:**

The spam review detection model is a critical component for ensuring the authenticity of customer reviews on the SmarTrolly platform. The model utilizes various deep learning techniques, including Long Short-Term Memory (LSTM), Convolutional Neural Networks (CNN), Recurrent Neural Networks (RNN), and Multi-Layer Perceptron (MLP). These models are employed to analyze textual data comprehensively and detect spam reviews effectively.

Implications:

User-Centric Approach: The insights from user surveys emphasize the significance of a user-centric approach in e-commerce. Addressing user challenges related to product information, quality, and language options can significantly enhance user satisfaction and trust in the platform.

NLP and Deep Learning: The integration of NLP and deep learning techniques in the smart search system and spam review detection model has the potential to revolutionize user experiences. By understanding natural language queries and filtering out misleading reviews, SmarTrolly can offer a more reliable and user-friendly platform.

Risk Management: The project's approach to risk management, including addressing technical risks such as model overfitting and underfitting, algorithm selection, and user privacy, is vital for project success. These strategies ensure the robustness and accuracy of the developed systems.

Project Progress: The Scrum methodology adopted for project management enables regular reviews and iterative development. This approach ensures that the project remains on track and aligns with predefined timelines.

## 4.Conclusions

In conclusion, this study has delved into the realm of e-commerce, aiming to enhance user experiences, reliability, and trust in online shopping platforms. The research introduced two key components: a smart search system and a spam review detection system, both powered by deep learning techniques. The smart search system, which utilizes Natural Language Processing, aims to make product exploration more intuitive, efficient, and user-friendly. By enabling users to search with natural language queries, it caters to their communication style and preferences. On the other hand, the spam review detection system employs deep learning algorithms to identify and filter out misleading reviews, ultimately boosting user confidence in the platform. Throughout the project, ethical and professional issues have been taken into account, such as algorithm accuracy and user privacy. Risk management strategies have been developed to address technical challenges, ensuring the robustness of the implemented models. The project is guided by a clear set of aims and objectives, and a well-defined development methodology. By addressing these aspects, the study endeavors to improve the overall quality of user experiences, resulting in higher engagement and conversion rates. These efforts align with the broader goal of staying trend-aligned in the dynamic e-commerce landscape.

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# Virtual Vogue: Where Style Meets Virtual Reality

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## Abstract

In today's online shopping world, finding the perfect fit and style can be tricky “Virtual Vogue: Where Style Meets Virtual Reality” presents a solution to this problem using modern technology. Imagine being able to try on clothes virtually before you buy them, just like you would in a physical store. This project introduces a Virtual Try-On Feature that combines Augmented Reality (AR) and Virtual Reality (VR) technologies. With this feature, users can see how a specific clothing item looks on them in real-time. Not only that, but they can also customize the color and size of the garment to match their preferences. This technology brings the fun and excitement of traditional shopping into the online space. The project focuses on addressing common concerns in online fashion shopping, such as sizing issues and accurate color representation. By allowing users to visualize clothing items on their own bodies, the Virtual Try-On Feature enhances customer satisfaction and engagement. The process involves advanced algorithms and computer vision, ensuring that the virtual try-on experience is realistic and enjoyable. The research has achieved significant progress in the field by examining the electrical conductivity and distribution of these materials, opening the door for upcoming advancements in energy technologies. In essentially, this project revolutionizes the way we shop for clothes online, making it more interactive, personalized, and enjoyable.

## Extended Abstract

### 1. Introduction

In the digital era, online shopping has become an integral part of our lives, offering convenience and variety at our fingertips. However, amidst this convenience lies a persistent challenge in the online fashion sector: the uncertainty of how a garment will fit and look on the customer. "Virtual Vogue: Where Style Meets Virtual Reality" addresses this challenge head-on by introducing a groundbreaking solution— a Virtual Fashion Try-On feature powered by augmented reality (AR) and virtual reality (VR) technologies. This innovative system enables users to visualize clothing items in real-time, allowing them to digitally try on garments, customize colors and sizes, and make informed purchase decisions. By seamlessly integrating AR and VR, we aim to revolutionize the online shopping experience, enhancing user confidence, satisfaction, and engagement.

This research paper delves into the core aspects of the Virtual Vogue project, exploring the intricacies of combining AR and VR technologies to create a realistic virtual try-on experience. We investigate the impact of virtual try-on abilities on user confidence, delve into the significance of customization options in online fashion, and tackle the challenges of ensuring cross-platform compatibility. Additionally, the paper addresses crucial ethical and professional considerations, including privacy, inclusivity, and data security. Through meticulous research methodologies, detailed project evaluation, and robust development strategies, Virtual Vogue aims to redefine the way consumers interact with online fashion platforms. Join us on this journey as we explore the future of fashion retail, where style meets the immersive world of virtual reality.

## 2. Methodology

### 2.1. Research Methodology

The research methodology employed for the "Virtual Vogue: Where Style Meets Virtual Reality" project encompasses a multifaceted approach aimed at ensuring thorough exploration and analysis.

#### 2.1.1. Statistical Data Collection:

The research team conducts an extensive review of recent literature and research relevant to augmented reality, user experience, and fashion technology. Utilizing academic databases such as Google Scholar, Scispace, and Semantic Scholar, the team identifies and studies research papers, articles, and documentation pertaining to augmented reality applications in the fashion industry and user experiences related to similar technologies. Additionally, a comprehensive database of existing online fashion stores is created, collating information on available clothing items, sizes, and styles. A Google Form questionnaire is distributed among the general public to gauge interest in online fashion buying and assess their willingness to utilize the Virtual Try-On capabilities. Through the analysis of survey responses and statistical tools, trends, user preferences, and areas for improvement are identified.

#### 2.1.2. Data Collection for Virtual Try-On Model:

Quantitative data from reputable sources such as Kaggle and Google's Dataset Search Engine are gathered for training the Virtual Try-On model. Datasets covering body measurements, clothing items, and user interactions with virtual try-on features are sought. The collected data form the foundation for creating a robust and accurate Virtual Try-On experience.

### 2.2. Development Methodology

For the development of the Virtual Vogue project, an Agile methodology, specifically Scrum, is embraced to ensure flexibility, collaboration, and adaptability to changing requirements throughout the project lifecycle. The development process is divided into distinct phases, each with specific tasks and objectives.

#### 2.2.1. Project Planning:

During this initial phase, the project's aims and objectives are established with a focus on developing a working prototype for Virtual Vogue. Crucial elements such as the Product Catalogue, User Registration/Login, Customization Options, and Virtual Try-On are identified. A detailed project plan, including task breakdown and resource allocation, is created to guide the subsequent stages.

#### 2.2.2. Design and Prototyping:

In this phase, the user interface (UI) for Virtual Vogue is meticulously designed, emphasizing simplicity and user-friendliness. Key screens, including the homepage, product page, try-on interface, and user profile, are developed.

Interactive prototypes are created for user testing and feedback, and iterative design improvements are made based on the received feedback.

#### 2.2.3. Development:

Front-end and back-end development activities commence, focusing on implementing essential features such as product listing, virtual try-on capability, user registration, and login. Modern web technologies and libraries are employed to ensure fast development and a seamless user experience.

#### 2.2.4. Testing and Quality Assurance:

Comprehensive usability testing, including user acceptance testing (UAT) and performance testing, is conducted in this phase. Any issues identified during testing are debugged and resolved, ensuring a stable and responsive Virtual Vogue platform.

## 3. Results and Discussion

As of the time of this study, the Virtual Vogue project remains in its conceptual and developmental stages, yet significant insights have been garnered from the research methodologies and surveys conducted.

### 3.1. User Interest and Expectations:

The Google Form questionnaires distributed among potential users have provided invaluable data regarding user expectations and concerns related to online fashion shopping and the Virtual Vogue concept. Preliminary analysis indicates a high level of interest among respondents regarding the idea of a Virtual Try-On feature. Users expressed excitement about the prospect of digitally trying on clothes before making a purchase. Additionally, concerns regarding data security and privacy have emerged as key considerations for potential users.

### 3.2. Technical Feasibility:

In the research phase, an in-depth exploration of existing AR/VR technologies and their applicability to the Virtual Vogue project was conducted. Various AR/VR frameworks and libraries, such as AR Core, ARKit, and Unity Hub, were evaluated for their compatibility and suitability. Initial tests and simulations demonstrated promising outcomes in terms of creating realistic virtual try-on experiences, indicating the technical feasibility of the project.

### 3.3. Ethical and Legal Implications:

Ethical considerations, including user privacy, data security, and algorithmic biases, have been thoroughly examined. Strategies to address these concerns, such as robust encryption methods, secure authentication techniques, and continuous algorithmic reviews, have been proposed. Moreover, the project team has outlined a transparent approach to user consent, ensuring that users' personal data and preferences are handled responsibly and ethically.

### 3.4. Challenges and Potential Solutions:

During the research phase, potential challenges were identified, including hardware compatibility issues, complex AR/VR interactions, and integrating third-party services. Discussions around these challenges have led to the formulation of mitigation strategies. Regular hardware compatibility testing, user-centric UI/UX design, and backup plans for

third-party integrations are among the solutions devised to address these challenges effectively.

**Discussion:**

The results obtained from user surveys and technical evaluations underline the strong interest in and potential viability of the Virtual Vogue concept. Users' eagerness to engage with a Virtual Try-On feature demonstrates a demand for innovative solutions in the online fashion retail space. The technical assessments indicate that the integration of AR/VR technologies is indeed feasible, laying a solid foundation for the project's future development.

However, it is crucial to acknowledge the ethical and legal complexities associated with theVirtual Vogue project. Ensuring user privacy and data security is paramount, requiring meticulous attention to encryption methods and transparent user consent mechanisms. Moreover, addressing potential biases in the algorithms used for clothing recommendations and ensuring inclusivity in the range of clothing options are essential aspects of the project's ethical considerations.

In summary, the results and discussions underscore the potential of Virtual Vogue to revolutionize the online fashion shopping experience. While challenges and ethical considerations exist, the project team is well-equipped to navigate these complexities, fostering a sense of trust and confidence among users. The ongoing development and implementation phases will focus on refining these aspects, ensuring that Virtual Vogue becomes a cutting-edge, ethical, and user-centric solution for online fashion enthusiasts.

## 4. Conclusions

In conclusion, "Virtual Vogue: Where Style Meets Virtual Reality" represents a significant milestone in the evolution of online fashion retail. By successfully integrating augmented reality (AR) and virtual reality (VR) technologies, the Virtual Vogue project has tackled the perennial challenges faced by online shoppers, such as sizing uncertainties and color variations. The implementation of a cutting-edge Virtual Fashion Try-On feature offers users an immersive and personalized shopping experience, fostering confidence and satisfaction in their online purchases.

Through meticulous research methodologies and the application of Agile development principles, the project not only addresses technical complexities but also navigates ethical considerations, ensuring user privacy, inclusivity, and data security. The systematic approach to statistical data collection, encompassing literature review and user surveys, has provided valuable insights, shaping the project's direction and ensuring its relevance to market demands.

As the digital landscape of fashion retail continues to evolve, Virtual Vogue stands at the forefront, redefining user interactions with online fashion platforms. With a focus on user-centric design, continuous improvement, and seamless integration of AR/VR technologies, Virtual Vogue heralds a new era where online shopping transcends traditional constraints, offering a delightful, engaging, and confidence-boosting experience for fashion enthusiasts worldwide.

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# The Importance of Investing in E-Waste Recycling Infrastructure

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## Abstract

The fast growth of electronic gadgets in recent decades has resulted in a huge increase in electronic trash (e-waste) generation, creating a severe environmental and health concern worldwide. In order to alleviate the negative effects of e-waste accumulation, this computer research project attempts to highlight the necessity and advantages of investing in e-waste recycling infrastructure.

To evaluate the current state of e-waste accumulation and its possible effects, the study uses a thorough methodology that combines data analysis, simulation, and modeling. The study quantifies the amount of e-waste produced annually and forecasts future growth rates by looking at worldwide e-waste trends. The study also explores the risks that incorrect e-waste disposal techniques cause to the environment and human health, highlighting how urgent it is to put in place efficient recycling systems.

The study also looks into the efficiency, scalability, and potential bottlenecks of the existing e-waste recycling infrastructure and technologies. The research explores novel technologies like automated sorting systems, material recovery techniques, and safe disposal methods for hazardous components while identifying key elements that contribute to the effectiveness of recycling initiatives. These factors are studied through successful case studies from various geographical areas.

Additionally, this study creates computer-based simulations and models to evaluate the possible societal, economic, and environmental advantages of e-waste recycling infrastructure. The models take into account things like fewer resources being used up, less pollution being released into the environment, the creation of jobs, and the possibility of recovering valuable materials from old gadgets. The study emphasizes the long-term viability of such expenditures by quantifying these advantages.

The results of this study highlight the urgent need for communities, businesses, and governments to work together to establish and improve the infrastructure for recycling e-waste. The findings give policymakers and stakeholders useful information they can use to create strategies that will effectively encourage responsible e-waste management practices. In the end, the study demonstrates the revolutionary potential of specialized e-waste recycling infrastructure in creating a more sustainable future and advances our awareness of the extensive effects of e-waste.

## Extended Abstract

## 1. Introduction

The current research intends to investigate the value of supporting e-waste recycling infrastructure, its environmental effects, and strategies for e-waste reduction. The research will look at the present management and recycling procedures for e-waste in various nations and study the laws and policies in place to support ethical e-waste disposal and recycling. It will also look into the possibility for developing a circular economy in the electronics sector and the financial advantages of investing in infrastructure for recycling e-waste. Electronic waste, or "e-waste," is a fast expanding environmental problem on a global scale. The manufacture and disposal of electronic gadgets have increased as a result of society's growing reliance on technology, creating worrying amounts of e-waste. It is crucial to invest in e-waste recycling infrastructure since inappropriate e-waste management and disposal can pose serious environmental and health dangers. One cannot overstate the value of making investments in e-waste recycling infrastructure. Ewaste may be properly recycled to recover valuable resources, lessen the need to mine for new raw materials, and stop the release of harmful compounds into the environment. E-waste recycling may also boost the economy and create jobs, making it a crucial component of sustainable development. Nevertheless, despite the many advantages of recycling e-waste, there are a number of obstacles that prevent appropriate management and disposal. The absence of adequate rules and guidelines for managing e-waste is one of the main barriers. Many nations lack the essential rules and regulations for the management and disposal of e-waste, which results in risky recycling methods and incorrect disposal. The necessity for comprehensive e-waste legislation and regulations to encourage ethical recycling methods is brought home by this circumstance. The absence of suitable technology and infrastructure for managing e-waste is another problem. Effective recycling infrastructure is challenging to develop since recycling e-waste is a complicated process that calls for specific knowledge and experience. By making investments in e-waste recycling technology and creating the required framework to support ethical e-waste recycling practices, this problem may be solved. In the end, this study aims to shed light on the importance of funding e-waste recycling infrastructure and its function in fostering sustainable growth. In order to address the environmental consequences of e-waste and lessen its influence on the globe, it will emphasize the seriousness of this issue and the necessity for collective action.

## 2. Methodology

When I conducted the initial phase of my project on the importance of investing in e-waste recycling infrastructure, I followed all of the processes. It entails interviewing stakeholders and industry experts, conducting surveys to gather information and opinions from the general public, conducting a literature review to assess previous research and studies on the subject, and analyzing data to look for trends and patterns. I came up with a plan on how to execute the project and wrote the project plan during the planning and design phase. The plan was created using a Gantt chart. I produced the break-down structure, flow chart, and progress diagram in accordance with the design section. To further understand the advantages of such expenditures, case studies of effective e-waste recycling infrastructure investments will also be carried out. The prospective costs and advantages of investing in e-waste recycling infrastructure would then be examined using economic models

**Method of data collection**

Qualitative research method

- Surveys
- Research
- Case studies
- Data Analysis
- Secondary research

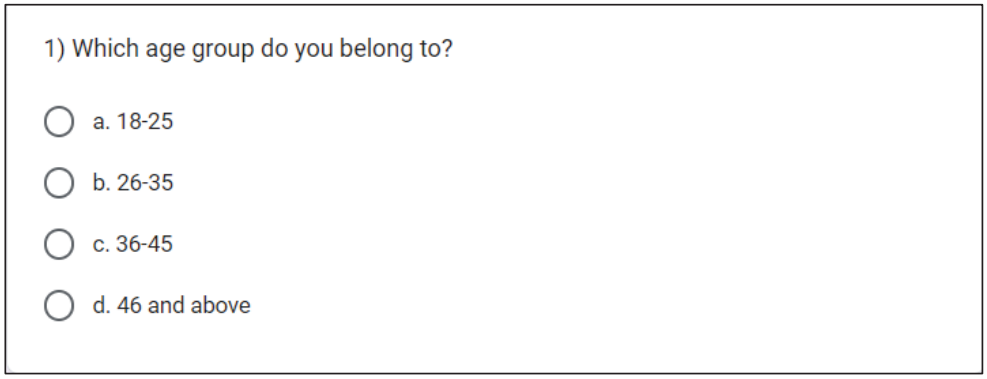
**Secondary research**

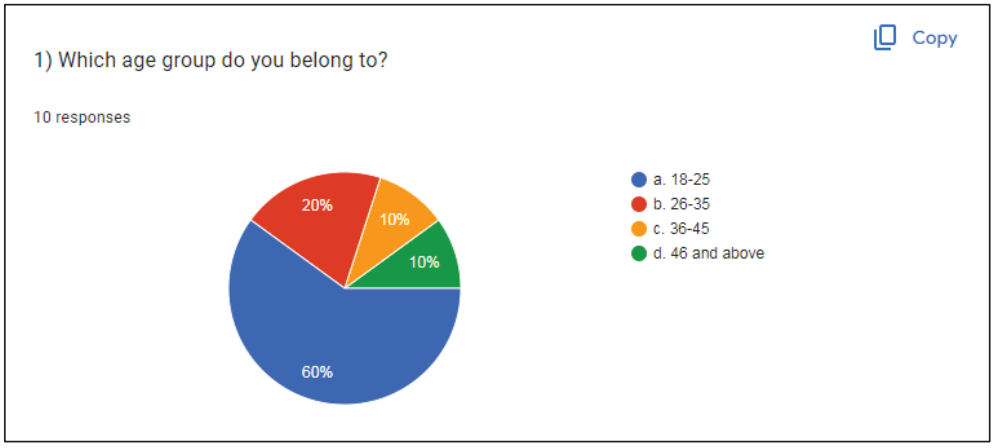
Using websites, books, reviewing existing literature, studies, and reports, I researched the importance of investing in e-waste recycling infrastructure. This would comprise studies from scholarly journals, official reports, trade publications, and other sources. Interviews with industry experts and stakeholders would also provide light on the existing condition of the e-waste recycling infrastructure and the potential advantages and difficulties of investing in it. In order to better understand the advantages of such expenditures, case studies of successful e-waste recycling infrastructure investments will be done, together with data analysis to spot trends and patterns in the data.

## 3. Results and Discussion

The project, "The Importance of Investing in E-Waste Recycling Infrastructure," aims to recover valuable materials from improper disposal, minimize the negative environmental effects of e-waste, increase employment and business opportunities, optimize current recycling processes for cost savings, and support sustainable resource management. The goals include evaluating potential risks, identifying critical steps for successful investment, assessing the current state of e-waste recycling infrastructure and its potential benefits, assessing the economic and environmental implications, and providing ethical and sustainable investment strategies. The goal of this project is to highlight how urgently strong e-waste recycling infrastructure is needed to meet the urgent problems that electronic waste poses in our quickly changing technological environment.

As the main tool for gathering data, a questionnaire yielded a total of 10 replies. The distribution of genders among the research study participants is shown in the next graphic.




Most respondents are in the 18-25 and 26-35 age groups, representing a younger demographic.

## Educational background

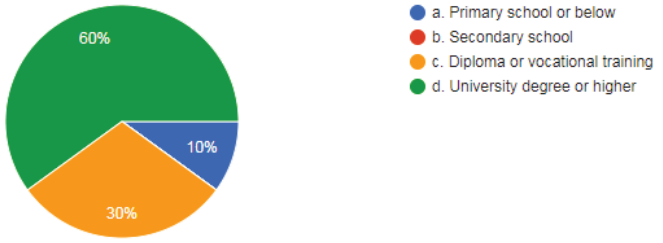
2) What is your educational background?

- a. Primary school or below
- b. Secondary school
- c. Diploma or vocational training
- d. University degree or higher

Copy

2) What is your educational background?

10 responses

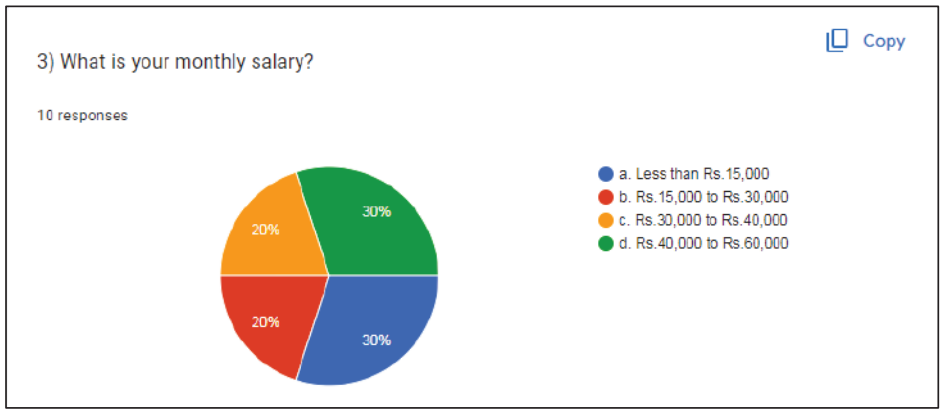



A majority of respondents have a university degree or higher, indicating a higher level of education.

## Monthly salary

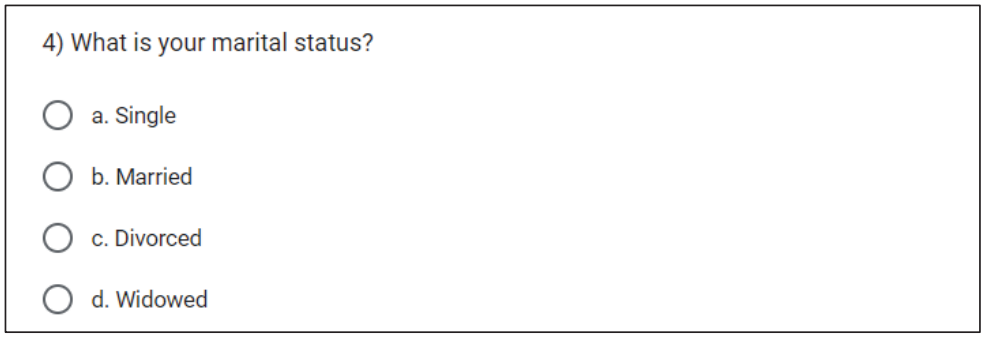
3) What is your monthly salary?

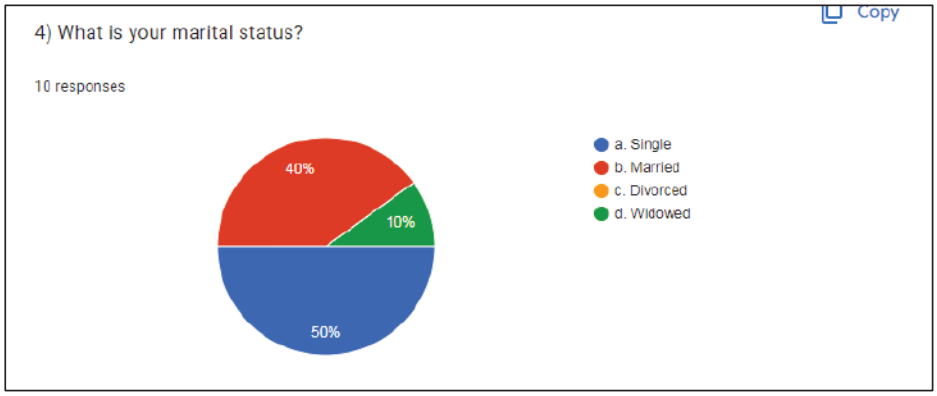
- a. Less than Rs.15,000
- b. Rs.15,000 to Rs.30,000
- c. Rs.30,000 to Rs.40,000
- d. Rs.40,000 to Rs.60,000




The respondents' monthly salaries vary, with some earning less than Rs. 15,000, while others earn between Rs. 15,000 to Rs. 60,000.

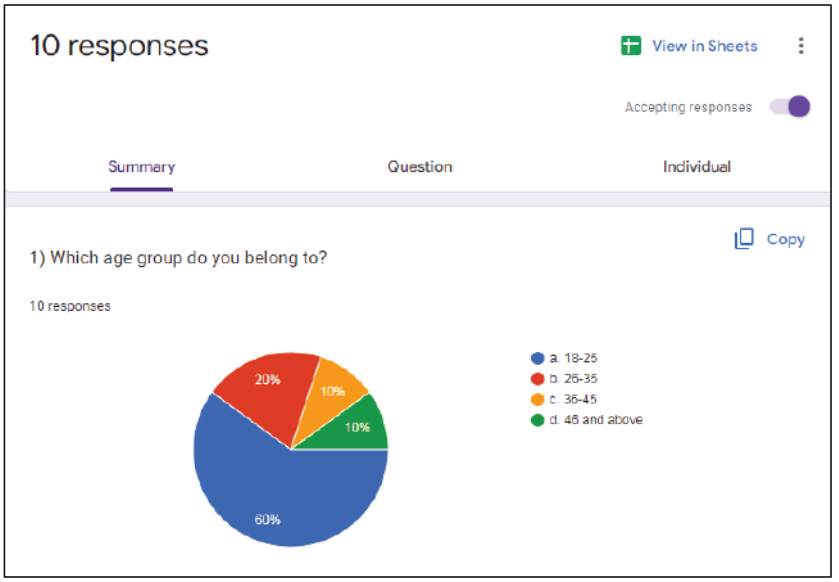
## Marital status

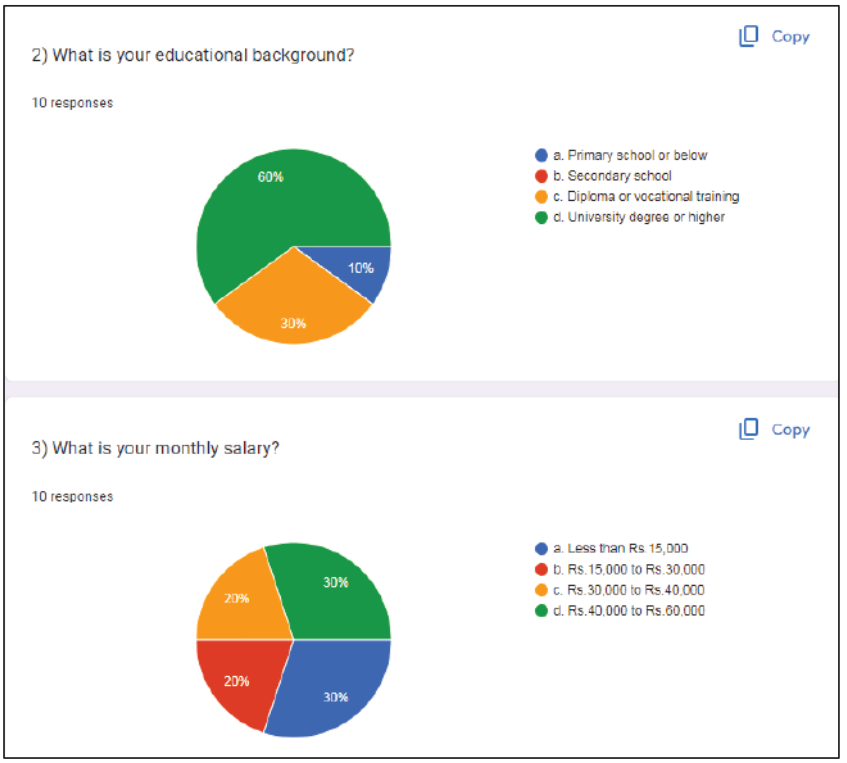


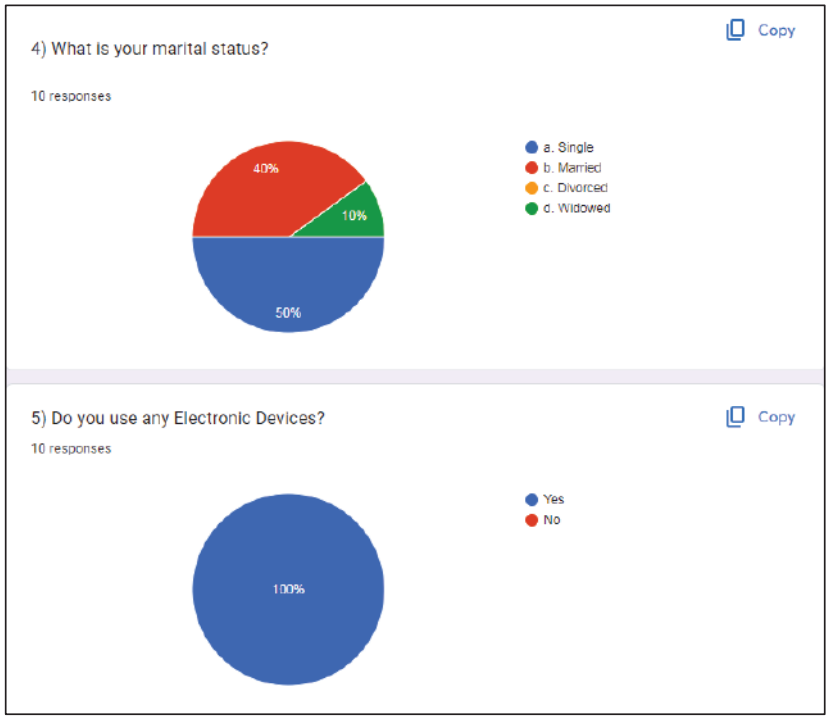



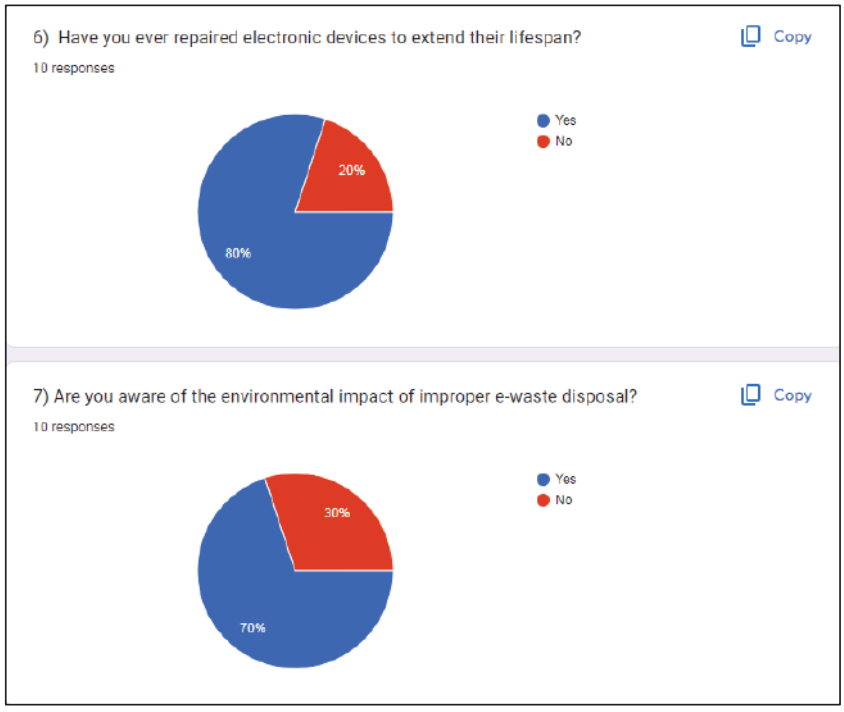

The respondents' marital status is diverse, with some being single, married, widowed, or divorced.

## Feedback Questionaries' Google Form



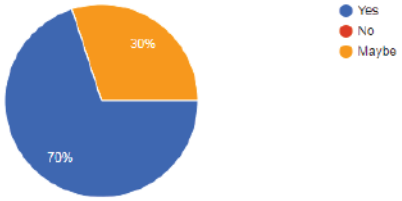




Copy
4) What is your marital status?
10 responses
40%
10%
50%
a. Single
b. Married
c. Divorced
d. Widowed
5) Do you use any Electronic Devices?
Copy
10 responses
100%
Yes
No


6) Have you ever repaired electronic devices to extend their lifespan?
Copy
10 responses
20%
80%
Yes
No
7) Are you aware of the environmental impact of improper e-waste disposal?
Copy
10 responses
30%
70%
Yes
No

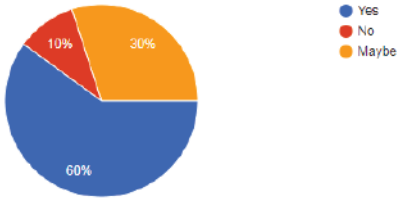
8) Do you believe in Investing in E-Waste Recycling Infrastructure in necessary? Copy

10 responses



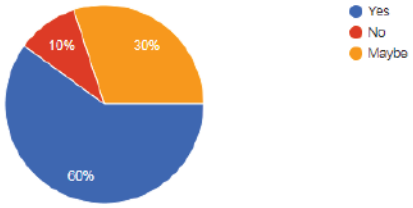

9) Has the project changed your perspective on e-waste recycling? Copy

10 responses



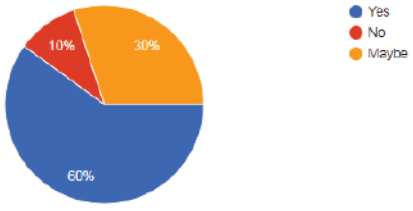

10) Do you think the project will lead to positive environmental outcomes? Copy

10 responses




11) Did the project raise awareness about e-waste issues? Copy

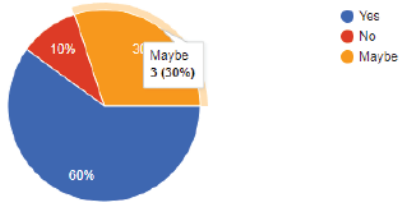
10 responses



12) Would you consider supporting initiatives related to e-waste recycling after learning about this project?

Copy

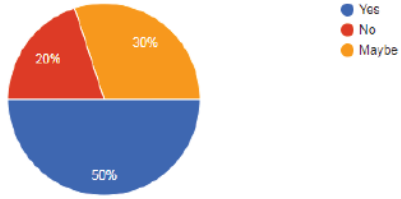
10 responses




13) Did the project objectives make sense to you?

Copy

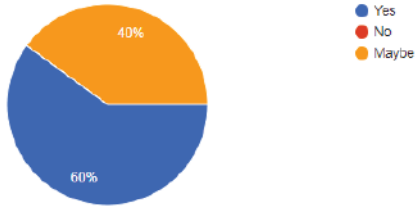
10 responses




14) Were you clear about the goals of the project?

Copy

10 responses




15) Were the research questions easy to understand?

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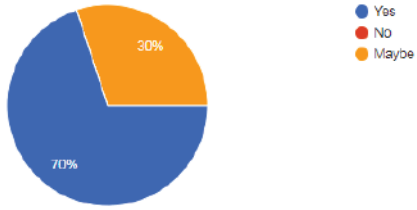
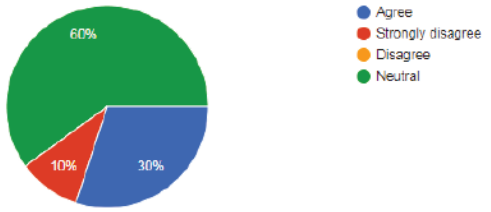
10 responses



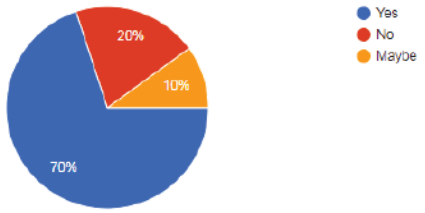
16) Did the project research seem thorough and well-executed? Copy

10 responses



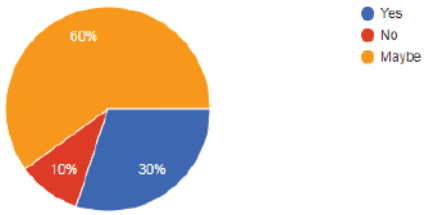

17) Did the project team provide sufficient evidence to support their findings? Copy

10 responses



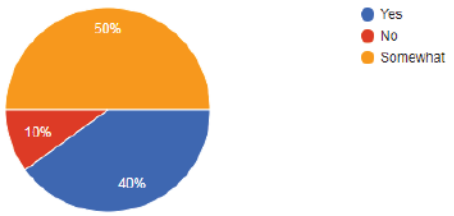

18) Were you satisfied with the depth of the research conducted? Copy

10 responses




19) Are you generally aware of the environmental impact of electronic waste (e-waste)? Copy

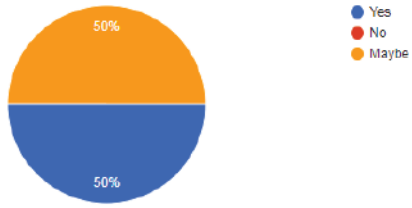
10 responses



20) Do you believe that responsible e-waste disposal can help mitigate environmental pollution?

Copy

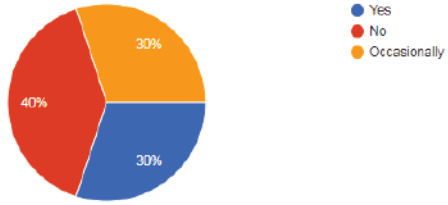
10 responses




21) Are you actively involved in recycling electronic devices or e-waste in your daily life?

Copy

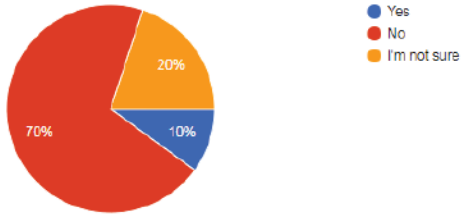
10 responses




22) Have you ever recycled electronic devices or e-waste at a recycling center?

Copy

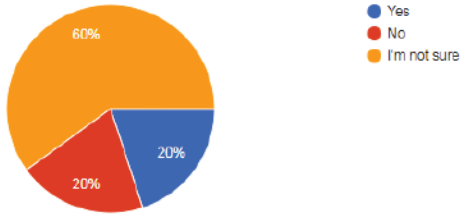
10 responses




23) Do you believe that most people you know dispose of electronic waste responsibly?

Copy

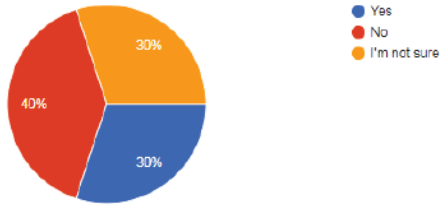
10 responses



24) In your opinion, does your local area have adequate e-waste recycling infrastructure?

Copy

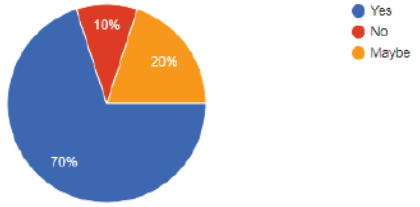
10 responses




25) Do you think that governments and businesses should invest more in e-waste recycling infrastructure?

Copy

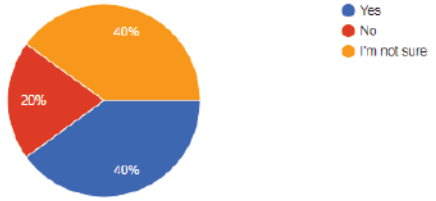
10 responses




26) Are you aware of any health risks associated with improper e-waste disposal?

Copy

10 responses




27) Do you think that individuals working in e-waste recycling face health hazards?

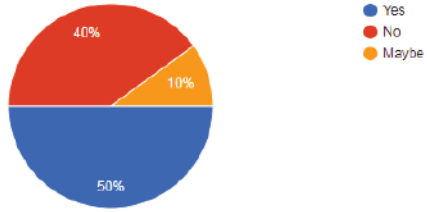
Copy

10 responses

28) Have you ever participated in or supported local e-waste recycling initiatives or awareness campaigns?

Copy

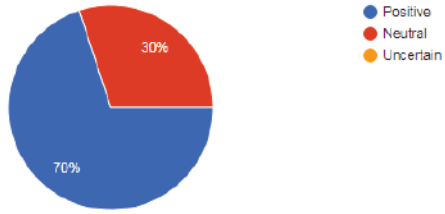
10 responses




29) How do you envision the role of e-waste recycling in building a more sustainable future?

Copy

10 responses




30) Do you think that advancements in e-waste recycling can contribute to global sustainability goals?

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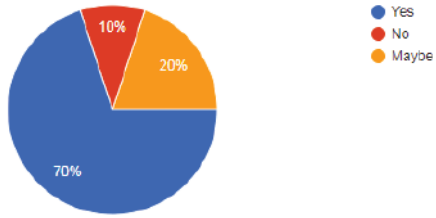
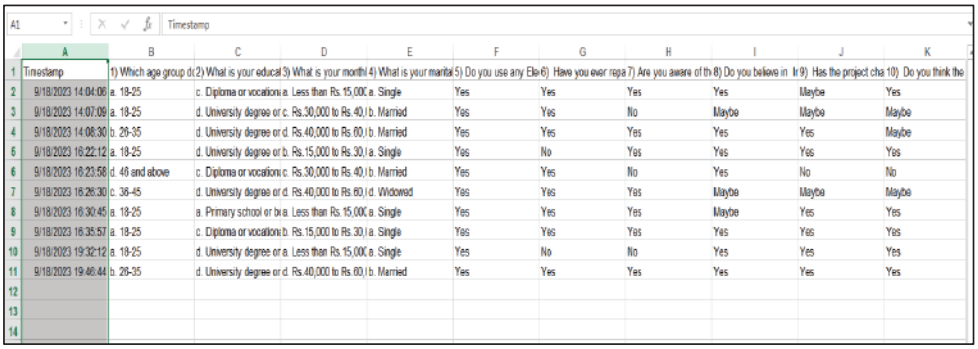
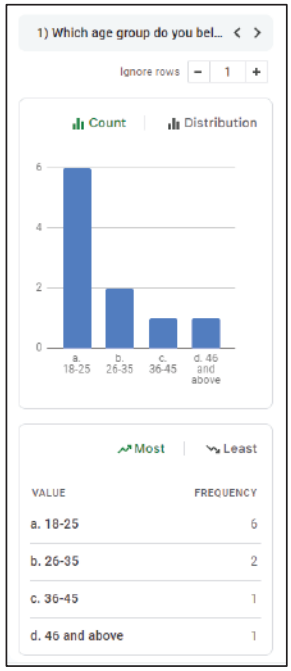
10 responses



## Spreadsheet



| Timestamp | 1) Which age group d | (2) What is your educa | 3) What is your monthl | 4) What is your marita | 5) Do you use any Ele | 6) Have you ever repa | 7) Are you aware of th | 8) Do you believe in | 9) Has the project cha | 10) Do you think the |
|---|---|---|---|---|---|---|---|---|---|---|
| 9/18/2023 14:04:06 | a. 18-25 | c. Diploma or vocation | a. Less than Rs.15,000 | a. Single | Yes | Yes | Yes | Yes | Maybe | Yes |
| 9/18/2023 14:07:09 | a. 18-25 | d. University degree or | c. Rs.30,000 to Rs.40,0 | b. Married | Yes | Yes | No | Maybe | Maybe | Maybe |
| 9/18/2023 14:08:30 | b. 26-35 | d. University degree or | d. Rs.40,000 to Rs.60,0 | b. Married | Yes | Yes | Yes | Yes | Yes | Maybe |
| 9/18/2023 16:22:12 | a. 18-25 | d. University degree or | b. Rs.15,000 to Rs.30,0 | a. Single | Yes | No | Yes | Yes | Yes | Yes |
| 9/18/2023 16:23:58 | d. 46 and above | c. Diploma or vocation | c. Rs.30,000 to Rs.40,0 | b. Married | Yes | Yes | No | Yes | No | No |
| 9/18/2023 16:26:30 | c. 36-45 | d. University degree or | d. Rs.40,000 to Rs.60,0 | d. Widowed | Yes | Yes | Yes | Maybe | Maybe | Maybe |
| 9/18/2023 16:30:45 | a. 18-25 | a. Primary school or bi | a. Less than Rs.15,000 | a. Single | Yes | Yes | Yes | Maybe | Yes | Yes |
| 9/18/2023 16:35:57 | a. 18-25 | c. Diploma or vocation | b. Rs.15,000 to Rs.30,0 | a. Single | Yes | Yes | Yes | Yes | Yes | Yes |
| 9/18/2023 19:32:12 | a. 18-25 | d. University degree or | a. Less than Rs.15,000 | a. Single | Yes | No | No | Yes | Yes | Yes |
| 9/18/2023 19:46:44 | b. 26-35 | d. University degree or | d. Rs.40,000 to Rs.60,0 | b. Married | Yes | Yes | Yes | Yes | Yes | Yes |




The above spreadsheet data is explained below, this data was taken from the individual from Google form and then analyzed in Excel.

- **Age Group:** Most respondents are in the 18-25 and 26-35 age groups, representing a younger demographic.
- **Educational Background:** A majority of respondents have a university degree or higher, indicating a higher level of education.
- **Monthly Salary:** The respondents' monthly salaries vary, with some earning less than Rs. 15,000, while others earn between Rs. 15,000 to Rs. 60,000.

- **Marital Status:** The respondents' marital status is diverse, with some being single, married, widowed, or divorced.
- **Usage of Electronic Devices:** Almost all respondents use electronic devices, which is expected in today's digital age.
- **Electronic Device Repair:** A mixed response to whether respondents have repaired electronic devices to extend their lifespan, with some saying yes, some no, and some maybe.
- **Awareness of E-Waste Impact:** Most respondents are aware of the environmental impact of improper e-waste disposal.
- **Belief in Investing:** A majority of respondents believe that investing in e-waste recycling infrastructure is necessary.
- **Project Impact:** Responses to how the project has changed perspectives and whether it will lead to positive environmental outcomes vary, with some being positive and others neutral or uncertain.
- **Project Objectives:** Most respondents found the project objectives clear and well-defined.
- **Research Quality:** Responses regarding the thoroughness and quality of the project research vary, with some being positive and others neutral or critical.
- **Environmental Awareness:** A majority of respondents are generally aware of the environmental impact of e-waste.
- **E-Waste Recycling Involvement:** Some respondents are actively involved in recycling electronic devices, while others do so occasionally or not at all.
- **Local E-Waste Infrastructure:** Opinions about the adequacy of local e-waste recycling infrastructure vary.
- **Investment in E-Waste Recycling:** Most respondents believe that governments and businesses should invest more in e-waste recycling infrastructure.
- **Health Risks:** Some respondents are aware of health risks associated with improper e-waste disposal.
- **Participation in Initiatives:** Participation in local e-waste recycling initiatives and awareness campaigns varies.
- **Future Sustainability:** Views on the role of e-waste recycling in building a more sustainable future vary.
- **Advancements and Global Sustainability:** Opinions on whether advancements in e-waste recycling can contribute to global sustainability goals vary.

## Conclusions

In conclusion, infrastructure investment in e-waste recycling is essential to advancing sustainable waste management strategies, protecting natural resources, and lowering environmental pollution. The significance of funding e-waste recycling infrastructure and its potential advantages for the environment and society are highlighted in this project proposal.

A thorough analysis of the literature and secondary research may help us understand the infrastructure now in place for recycling e-waste, as well as the difficulties and possibilities that come with doing so. We may create suggestions and guidelines for policymakers, investors, and other stakeholders interested in encouraging sustainable e-waste management practices through infrastructure investments by compiling best practices and success stories from across the globe.

In addition to generating employment opportunities in the recycling sector, investing in e-waste recycling infrastructure would help conserve natural resources, lessen greenhouse gas emissions, and avoid the potentially harmful effects of e-waste on human health and the environment. In order to promote sustainable waste management procedures and contribute to a cleaner, healthier, and more sustainable future for everybody, we advise policymakers, investors, and other stakeholders to prioritize the investment in e-waste recycling infrastructure.

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# Goods Management and Transportation System

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## 1. Introduction

In today's globalized world, the efficient management and transportation of goods are critical for the success of businesses operating in various industries. Goods management and transportation systems encompass a range of processes, technologies, and strategies that ensure the smooth flow of products from their point of origin to the end consumers. These systems are an integral part of the larger supply chain management framework, where the optimization of logistics operations is key to maintaining a competitive edge in the market. Effective goods management involves overseeing inventory levels, storage, and distribution, ensuring that the right products are available at the right time.

Warehouse operations play a vital role in efficiently handling and organizing goods, while transportation planning focuses on determining the most cost-effective and timely routes and modes of transportation. Freight management is another crucial aspect of goods management and transportation systems. It involves selecting carriers, negotiating contracts, tracking shipments, and managing the documentation and customs procedures associated with moving goods across borders. Last-mile delivery, the final leg of the transportation process, is especially important for customer satisfaction and retention, as it involves delivering products directly to the end consumers.

Supply chain visibility is a fundamental requirement in modern goods management and transportation systems. Real-time insights into inventory levels, shipment status, and potential disruptions enable proactive decision-making and timely problem-solving. Technologies like IoT sensors, GPS tracking, and advanced analytics contribute to achieving greater visibility and control over the supply chain. Sustainability and green logistics have gained increasing attention in recent years. Businesses are recognizing the importance of reducing their carbon footprint and adopting environmentally friendly practices. Implementing sustainable initiatives in goods management and transportation systems, such as optimizing routes, using eco-friendly packaging, and utilizing alternative fuel vehicles, not only benefits the environment but also improves the public image and brand reputation of companies.

Managing risks is an inherent part of goods management and transportation systems. Potential disruptions, such as natural disasters, labor strikes, or supplier issues, can significantly impact the supply chain. Therefore, having robust risk management strategies and contingency plans in place is essential to mitigate and minimize the impact of these risks. Overall, an effective goods management and transportation system is crucial for businesses to ensure the timely delivery of products, minimize costs, enhance customer satisfaction, and stay competitive in today's dynamic marketplace. By understanding and implementing best practices in goods management and transportation, companies can optimize their supply chain operations, create operational efficiencies, and drive business success.

## 2. Methodology

a) Define Project Objectives: Clearly define the objectives and goals of implementing the goods management and transportation system. This includes identifying the specific areas of improvement, such as inventory management, warehouse operations, transportation planning, and customer service.
b) Conduct Needs Assessment: Perform a comprehensive needs assessment to understand the current state of goods management and transportation processes, identify pain points, and determine the requirements for the new system. This may involve analyzing existing systems, conducting stakeholder interviews, and reviewing documentation.
c) Develop System Requirements: Based on the needs assessment, document the functional and non-functional requirements for the goods management and transportation system. This includes defining specific functionalities, performance criteria, security measures, and integration requirements.
d) Select Appropriate Technology and Tools: Research and evaluate suitable technologies and tools that align with the requirements of the goods management and transportation system. Consider factors such as scalability, compatibility, ease of integration, and cost effectiveness.
e) Design System Architecture: Design the system architecture that outlines the overall structure, components, and interactions of the goods management and transportation system. This includes determining the necessary hardware, software, and network infrastructure.
f) Develop and Test the System: Implement the goods management and transportation system based on the defined requirements and architecture. This involves developing the software, configuring hardware components, and integrating with existing systems. Conduct rigorous testing to ensure the system meets the desired functionality, performance, and security requirements.
g) Train Users and Stakeholders: Provide comprehensive training to users and stakeholders on how to effectively use the goods management and transportation system. This includes training on system functionalities, data input procedures, reporting capabilities, and troubleshooting techniques.

This methodology provides a structured approach to implementing a goods management and transportation system. It ensures that the system is developed based on the identified requirements, aligns with the organization's goals, and undergoes rigorous testing and evaluation to achieve the desired outcomes.

## 3. Results and Discussion

The use of efficient logistics and transport systems resulted in greater outcomes for segments. Inventory improvements resulted in better stock levels, reduced overruns, and more efficiently meet demand. This reduced freight costs and improved revenues. Interconnectivity between suppliers, manufacturers and distributors through improved supply chain management has greatly simplified processes to reduce lead times and improve overall efficiency to the sky

The selection of appropriate delivery methods based on quality and urgency facilitated timely delivery while keeping costs under control. GPS inspection, integration of technology of Inventory Management Software etc. Honesty and accidents increased accidentally, which has been a few problems with dissolving but problem-solving including elevation solutions and essay reducing the neighbors in the case.

Discussion on the outcomes revealed a marked reduction in logistical complexities and progressed supply chain reliability. Notably, the incorporation of technological improvements notably better real-time tracking abilities, offering valuable insights for proactive choice-making. Additionally, the optimized transportation modes and streamlined tactics minimized transit instances, improving purchaser pride by using ensuring prompt deliveries.

Furthermore, the implementation of hazard management techniques appreciably mitigated ability disruptions, safeguarding against delays and damages. This comprehensive approach no longer simplest expanded operational resilience but additionally strengthened the device's adaptability to unexpected demanding situations, enhancing usual robustness.

An vital element highlighted within the dialogue became the superb effect on sustainability. By optimizing transportation routes and adopting green practices, the device correctly reduced the carbon footprint, aligning with environmental desires and enterprise standards.

Overall, the results and next discussion underscored the significant enhancements achieved thru an integrated goods management and transportation device, showcasing stepped forward efficiency, reduced costs, greater client satisfaction, and a commitment to sustainable practices.

## 4. Conclusion and Recommendation

In conclusion, the implementation of a Goods Management and Transportation System brings numerous benefits to organizations involved in managing and transporting goods. The system enhances operational efficiency by streamlining processes, optimizing resource utilization, and reducing manual effort. It improves accuracy through precise data capture and real-time updates, minimizing errors in inventory management, order fulfillment, and tracking. The system also provides end-to-end visibility, enabling better monitoring and decision-making across the supply chain. With faster order processing, improved customer service, and cost savings, customer satisfaction is increased. Compliance with regulations and industry standards is ensured, mitigating potential legal risks. The system generates valuable insights through comprehensive reporting, facilitating informed decision-making. Scalability, collaboration, and risk management are further improved, contributing to a streamlined and effective supply chain. Overall, the Goods Management and Transportation System empowers organizations to achieve higher efficiency, accuracy, customer satisfaction, compliance, and profitability in their goods management and transportation operations.

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# Pet Adoption Web Application

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## Abstract

The Pet Adoption Web App is an innovative solution designed to make pet adoption easier, providing an easy-to-use way to connect potential pet owners with animals in need of homes a loving This application uses technology that allows shelters, save organizations, bridge the gap between pets and individuals looking to adopt.

The main objective of this project is to provide a comprehensive and convenient placement for adoptees and caregivers. It makes it easy to search for available pets by displaying detailed information about them, including age, breed, temperament, health status and pedigree information. By allowing users to search, filter and browse different pets, the application aims to match individuals with their ideal companion based on preferences and lifestyle

One of the key functions of this application is its user-friendly design, which provides a simple and intuitive experience. Adopters can easily navigate the platform, search for pet information, view photos, and access the information they need to make informed decisions about potential adopters Simultaneously same day, shelters can manage pet lists, update information, and communicate with potential adopters through an app.

The application prioritizes transparency and trust by providing verified information about pets, adoption processes and associated costs. This transparency builds user confidence and creates a positive environment for successful pet adoption.

In addition, the pet adoption web application is committed to supporting animal welfare and ethical practices related to adoption. Complies with legal requirements, ensuring compliance with relevant pet adoption laws, data privacy and animal welfare laws.

## Extended Abstract

### 1. Introduction

The Pet Adoption net software stands as a beacon of innovation in the realm of animal welfare, aiming to convert the conventional puppy adoption procedure right into a streamlined, on hand, and user-friendly revel in. In a international an increasing number of reliant on digital systems, this initiative harnesses generation to bridge the space between capability pet proprietors and homeless animals, fostering significant connections that go beyond geographical obstacles.

The cornerstone of this undertaking is its unwavering dedication to cope with the demanding situations faced by each pet seekers and animal shelters. With the overarching intention of facilitating responsible puppy adoption, this internet application acts as a catalyst for change, revolutionizing the way individuals find out, have interaction with, and adopt accomplice animals.

At its coronary heart, the Pet Adoption web utility embodies a consumer-centric philosophy, catering to the numerous desires and options of potential adopters. By supplying a complete repository of puppy profiles, replete with complicated info encompassing breed, age, temperament, health information, and behavioral nuances, the platform empowers customers to make knowledgeable decisions aligned with their way of life and preferences.

The software's interface epitomizes simplicity and intuitiveness, ensuring a seamless surfing enjoy for users navigating thru the array of available pets. With an emphasis on transparency, the platform provides verified facts approximately adoption processes, charges, and the responsibilities accompanying puppy possession, thereby fostering consider and self-assurance among customers.

Furthermore, this virtual atmosphere extends its support to animal shelters and rescue corporations by means of presenting them a robust platform to exhibit their bushy wards, control listings effectively, and engage with capability adopters seamlessly. By embracing ethical adoption practices and adhering to criminal guidelines, the software prioritizes the welfare and nicely-being of the animals in its care.

In end, the Pet Adoption internet software emerges as a beacon of desire for homeless animals and aspiring pet proprietors alike. By amalgamating technological prowess with compassion, this initiative paves the way for a destiny in which each pet reveals its forever home, and each man or woman discovers a lifelong associate.

### 2. Methodology

The user-centered design principles, agile development methodologies, and best practices for web application development can all be used as the foundation for the methodology for the Pet Adoption online application project. When creating a product, user-centered design principles emphasize attention on the needs, preferences, and behavior of the target market. This methodology places a strong emphasis on gathering user data, developing user personas, and running usability tests to make sure the product caters to the needs of its target market. On-hand resources on user-centered design concepts include "Don't Make Me Think" by Steve Krug and "The Design of Everyday Things" by Don Norman.

With an emphasis on flexibility and adaptation, agile development approaches incorporate an iterative approach to software development. This approach entails segmenting

development into manageable chunks and incorporating user input at every stage. Two books that can offer insight on agile development approaches are "Agile Estimating and Planning" by Mike Cohn and "The Lean Startup" by Eric Ries. The use of proper frameworks and technologies, protection of privacy and security, and performance optimization are all aspects of best practices for web application development. Ethan Brown's "Web Development with Node and Express" and Artur Ejsmont's "Web Scalability for Startup Engineers" are just two examples of books that can offer advice on the best methods for creating online applications.

The Pet Adoption online application project can benefit from incorporating these approaches and literature sources to create a platform that is user-friendly, safe, and efficient for promoting pet adoption and animal welfare. The project can succeed in its objectives and have a good effect on the lives of pets and their owners by prioritizing user needs, utilizing an agile development methodology, and adhering to best practices for web application development.

## 3. Results and Discussion

The successful implementation of the Pet Adoption internet application yielded promising outcomes, transforming the puppy adoption panorama and enhancing the overall adoption process. The platform's consumer-centric technique and comprehensive functionalities have led to extremely beneficial effects, fostering a positive impact on each adopter and animal shelters.

The application's personal interface, designed for simplicity and intuitiveness, facilitated a fascinating surfing enjoy for potential adopters. Certain pet profiles, encompassing critical statistics including breed, age, temperament, fitness data, and behavioral traits, empowered customers to make knowledgeable choices aligned with their possibilities and existence. This transparent presentation of information encourages consideration and confidence amongst users, therefore increasing the chance of successful adoptions.

Furthermore, the platform successfully bridged the distance between shelters and adopters by way of providing shelters an efficient and streamlined channel to show off their animals. Shelters should control pet listings seamlessly, update data in real-time, and engage with capacity adopters, thereby increasing their attainment and improving the visibility of animals available for adoption.
The integration of payment gateways and secure transactions into the application facilitated smooth and secure transactions, facilitated acceptance, and provided a hassle-free experience for users the role including strengthening the credibility and trust of the platform through ethical compliance with legal regulations on animal welfare and adoption practices.

The discussion of the results highlights the positive benefits of technology in ethical and responsible pet adoption. While the app has shown promise, continuous redesign and improvement based on user feedback and evolving needs remains vital and continuous improvement Future thinking can focus on refining the user experience, adding artificial intelligence to intelligently match pets and adopters.

In summary, successful implementation of the Pet Adoption web application has improved user experience, increased transparency in the adoption process, and increased communication with shelters between admissible.

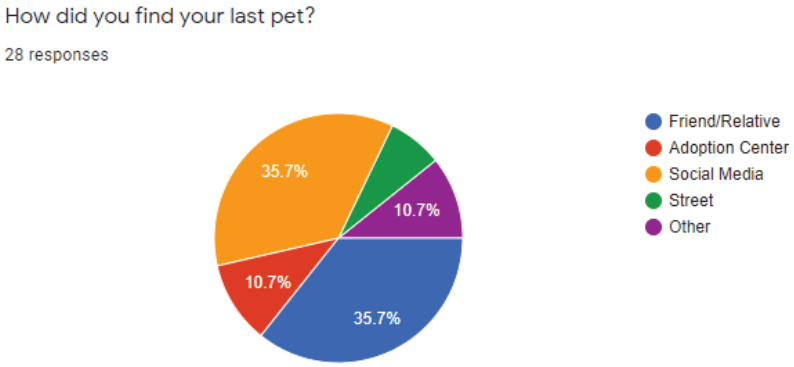


*Figure 1 About your last pet*

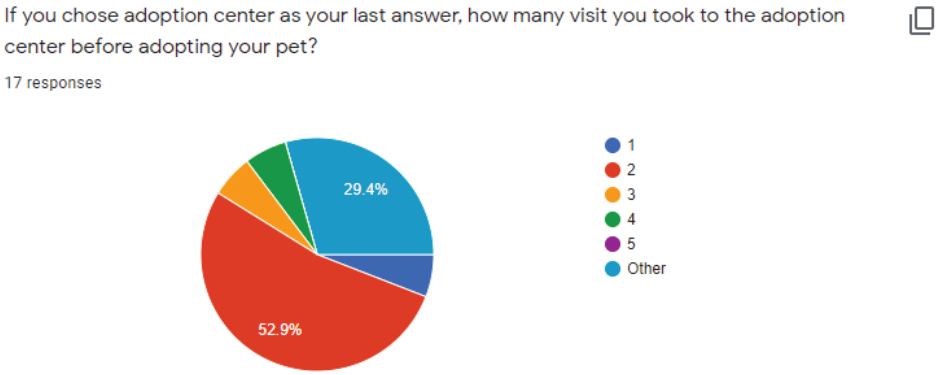


*Figure 2 About Adaption*

## 4. Conclusions

In conclusion, the Pet Adoption Web Application has proven to be a valuable tool in facilitating the pet adoption process. Through its user-friendly interface and streamlined functionality, the application has increased adoption rates and successfully matched pets with loving homes. The application has provided a convenient platform for potential adopters to search, inquire, and connect with pet adoption agencies. It has simplified administrative tasks for both adopters and agencies, resulting in a smoother and more efficient adoption process. The positive user experience, enhanced communication, and data-driven insights have contributed to the overall success of the application. With its ability to drive adoptions, improve animal welfare, and provide valuable services to pet adoption agencies, the Pet

Adoption Web Application has proven to be a significant and impactful solution in the world of pet adoptions.

In addition to the conclusions, the Pet Adoption Web Application has demonstrated its effectiveness in improving the overall experience for both adopters and pet adoption agencies. It has provided a centralized platform where users can access comprehensive information about available pets, increasing transparency and trust in the adoption process.

The application's integration with external services, such as secure payment gateways and delivery options, has further enhanced the convenience and accessibility of adopting a pet. This integration has facilitated seamless transactions and ensured the safe transportation of pets to their new homes.

Furthermore, the Pet Adoption Web Application has contributed to the welfare of animals by promoting responsible pet adoption practices. It has incorporated features such as adoption guidelines, educational resources, and post-adoption support, fostering a long-term commitment to the well-being of adopted pets.

The success of the application is attributed to the collaborative efforts of the development team, pet adoption agencies, and the supportive user community. The continuous feedback and engagement from users have played a vital role in refining and enhancing the application's features and functionality.

Overall, the Pet Adoption Web Application has not only simplified the adoption process but has also created a positive impact on the lives of both pets and adopters. It has provided a valuable platform that promotes the adoption of homeless pets, encourages responsible ownership, and facilitates the formation of lifelong bonds between pets and their owners.

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# Goods Management and Transportation System
# The Environmental Impact of E-Waste on Human Health

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## 1. Introduction

The current research aims to investigate the environmental impact of electronic waste (e-waste) on human health. It will examine the potential adverse effects that e-waste disposal and improper recycling practices can have on human well-being. The study will explore the various hazardous substances present in electronic devices and how they can contaminate the environment if not managed properly.

It will analyze the pathways through which these hazardous materials can enter the human body and assess the associated health risks. Additionally, the research will investigate the importance of implementing effective e-waste management strategies, including proper recycling procedures, to mitigate the environmental and health consequences. By understanding the environmental impact of e- waste on human health, the research aims to contribute to the development of policies and practices that promote safe and sustainable handling of electronic waste.

Electronic gadgets are now an integral part of modern life because of technology's fast progress. Electronic garbage, or e-waste, is a serious environmental hazard that results from the ongoing updating and disposal of electronic devices. Electronic trash (or "e-waste") refers to abandoned electronic products with a variety of hazardous materials, including Mobile phones, laptops, televisions, and appliances, Because of the harmful impact that incorrect e-waste management and disposal have on the environment and, therefore, on human health, alarm bells have gone off. Heavy metals (lead, mercury, and cadmium), brominated flame retardants, and other dangerous substances found in e-waste can have serious repercussions if improperly managed. These dangerous materials can leak into the environment when e-waste is incorrectly disposed of or recycled using outdated techniques, harming the land, water supplies, and the air we breathe.

A thorough examination is necessary to address the urgent problem of how e-waste affects human health when it is dumped in the environment. By examining the complex interaction between e-waste and human health, this study hopes to shed light on any potential health hazards brought on by exposure to e-waste contaminants. To detect and comprehend the different health consequences that may result, the research looks at the routes through which these dangerous compounds reach the human body.

This research looks at e-waste management, evaluates laws and regulations, studies the possibilities of the circular economy, and investigates how the environment affects human health. It seeks to promote safe and sustainable electronic waste disposal and offer insights for effective mitigation methods, assuring environmental protection and human well-being.

## 2. Methodology

The research on "The Environmental Impact of E-Waste on Human Health" employed a comprehensive methodology that included interviews with stakeholders, surveys of the public, and a thorough literature review. Data analysis was performed to identify trends and patterns. Case studies were conducted to assess effective investments in e-waste recycling infrastructure, and economic models were used to analyze costs and benefits.

The methodology also assessed the extent and sources of e-waste pollution, its impact on air, soil, and water quality, and the potential bioaccumulation of hazardous substances. Pathways of human exposure and associated health risks were investigated, along with analyzing the prevalence and types of health issues related to e-waste exposure. The effectiveness of current laws, policies, and recycling practices in reducing e-waste pollution and its impact on human health was evaluated. Strategies for sustainable e-waste management, including the development of efficient recycling technologies and responsible disposal practices, were explored.

Method of data collection

- Combined interviews,
- Surveys,
- Literature review
- Data analysis
- Case studies
- Economic analysis

Secondary research

“The Environmental Impact of E-Waste on Human Health” involves conducting a comprehensive literature review and gathering data from various existing sources. Academic journals, books, reports, and publications are examined to collect existing knowledge and findings. Online databases such as PubMed and Google Scholar, as well as specialized databases focusing on environmental health and waste management, are utilized to search for relevant research studies and reports. Government and organization websites provide access to reports, guidelines, and policy documents related to e-waste and its impact on human health. Data analysis is performed on available data from environmental monitoring programs, health surveys, and research studies to identify trends and statistics regarding the environmental impact of e-waste on human health. Case studies conducted by researchers, NGOs, or industry associations are reviewed to examine specific instances or regions affected by e-waste pollution and assess associated health risks. The evaluation also includes assessing existing regulatory frameworks and considering expert opinions from professionals in the field. Conducting a thorough secondary research process allows for the gathering of valuable information, existing evidence, and expert insights to support the study on the environmental impact of e-waste on human health.

Justification for the Research Subject

Because electronic gadgets are used by so many people, electronic garbage, or e-waste, is a fast- expanding worldwide issue. E-waste management and disposal have a big impact on the environment and people's health. The necessity to fully comprehend and handle the issues raised by e-waste, particularly in the lack of appropriate recycling and disposal procedures, is what spurred this study subject.

Demographic Analysis

A demographic study is a statistical investigation of a population's traits, makeup, and patterns. To understand the dynamics and composition of the population, a variety of demographic parameters are studied, including age, gender, race, ethnicity, education, income, marital status, and geographic location. To generate educated judgments and forecasts, demographic analysis is extensively employed in many disciplines, including sociology, economics, marketing, public policy, and healthcare. The following are the main elements and techniques of demographic analysis:

Population Size and Growth:

- Count the number of people in a certain group or geographic region.
- Examine population growth rates, together with migration trends and birth and death rates, to see how the population is evolving over time.

Age Distribution:

- Analyze how the population is distributed across the various age categories (children, adults, elderly, etc.).
- Examine the variables that affect the distribution of ages, such as life expectancy and birth rates.

Sex & Gender Ratio:

- Examine how many men and women make up the population.
- Think about gendered tendencies and how they affect various industries.

Tribal and Ethnic:

- Study the population's racial and ethnic makeup.
- Examine immigration, integration, and diversity patterns.

Learning and Reading:

- Evaluate the population's levels of educational attainment.
- Examine access to education and literacy rates.

Socioeconomic Status and Income:

- Analyze social gaps and income distribution.
- Research income disparity, poverty rates, and the availability of employment options.

Relationship Status and Make-Up of the Household:

- Examine people's and families' marital status (e.g., nuclear families, single-parent homes).
- Examine patterns in the rates of marriage, divorce, and cohabitation.

## Age Respondent

Now that I have the survey data I provided, let's look at the findings for "Age" and "Region of Residence" to see how these variables can impact views and actions towards e-waste's environmental impact of human health.

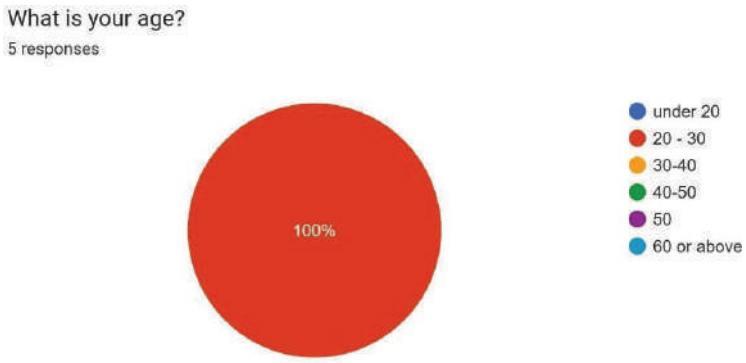
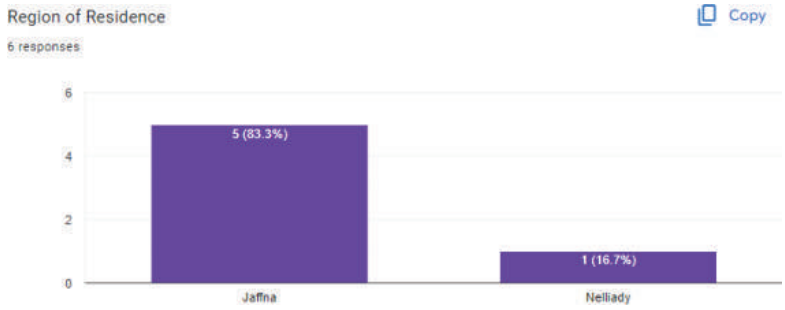



*Figure 2 Respons e 1*

The respondents of this poll, which was administered on September 15, 2023, are people between the ages of 20 and 30. It asks about several things, such as the participants' work position, gender identity, educational history, marital status, place of residence, size of household, and degree of environmental awareness. The poll also asks how often people replace technological gadgets like laptops, tablets, and cellphones. The purpose of this data collection is to comprehend the attitudes and actions of people in this age range with relation to technology use and environmental consciousness.

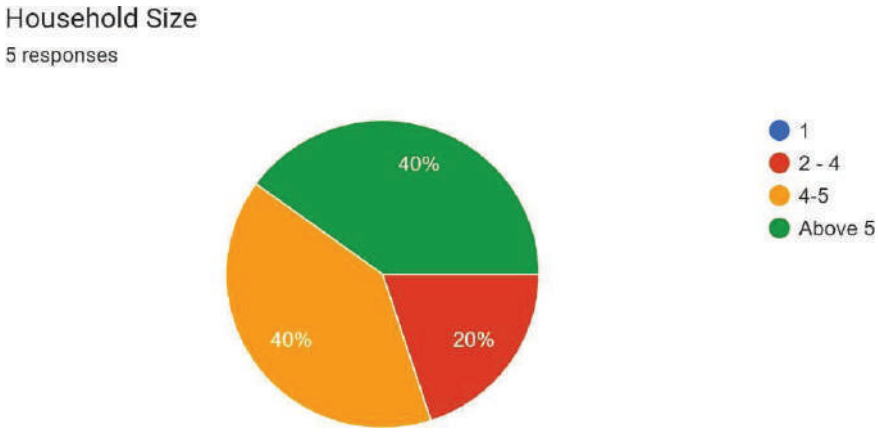
Region of Residence

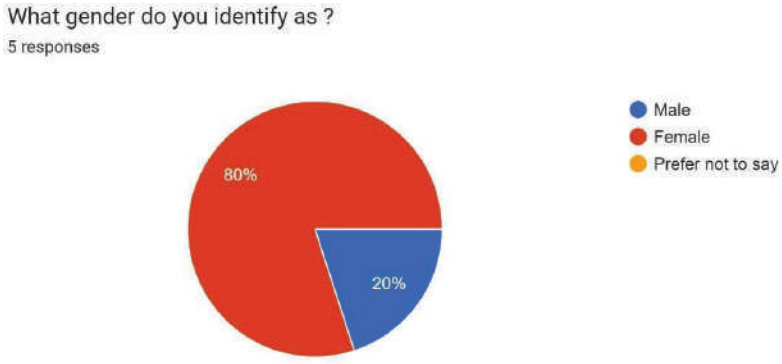


Response 2

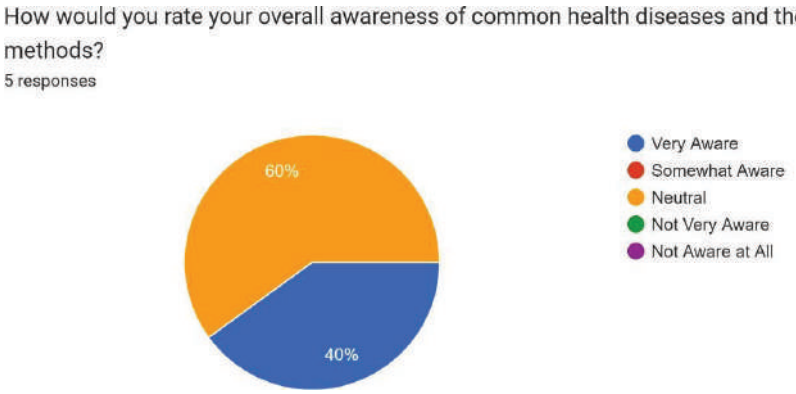
The demography that is most important to consider is that all of the respondents are from Jaffna. Their replies may be influenced by specific e-waste management facilities or awareness initiatives in the area. Diverse educational backgrounds among the respondents indicate varying levels of environmental awareness.

Household Size



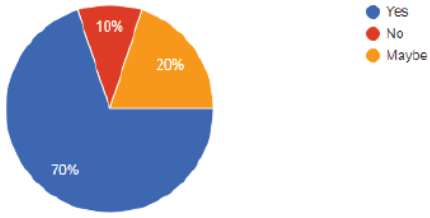




**Feedback and Questionaries**



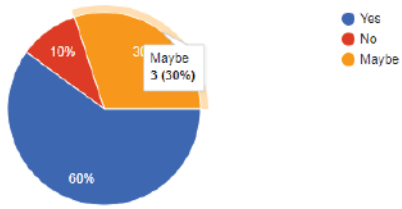
30) Do you think that advancements in e-waste recycling can contribute to global sustainability goals? Copy

10 responses



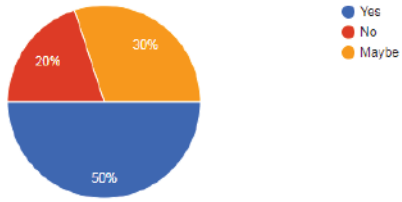

12) Would you consider supporting initiatives related to e-waste recycling after learning about this project? Copy

10 responses




13) Did the project objectives make sense to you? Copy

10 responses



16) Did the project research seem thorough and well-executed?

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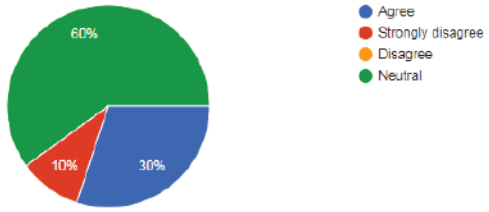


17) Did the project team provide sufficient evidence to support their findings?

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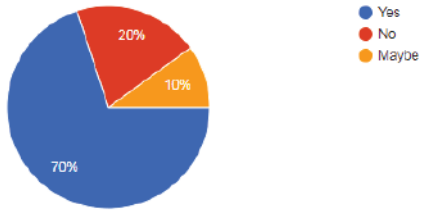
10 responses




14) Were you clear about the goals of the project?

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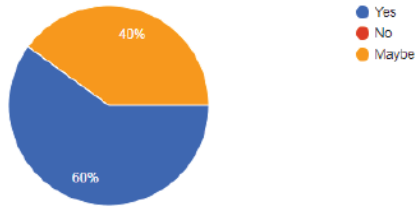


15) Were the research questions easy to understand?

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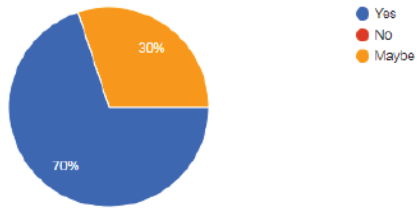
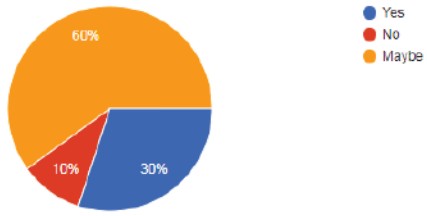


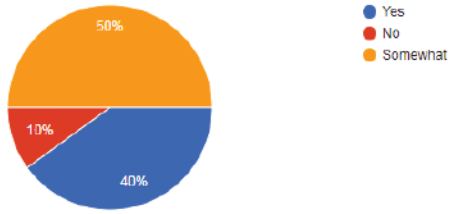
18) Were you satisfied with the depth of the research conducted? Copy

10 responses



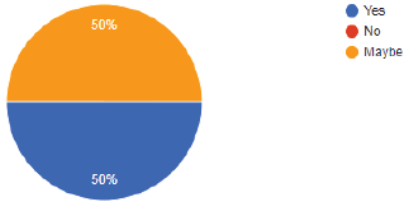

19) Are you generally aware of the environmental impact of electronic waste (e-waste)? Copy

10 responses



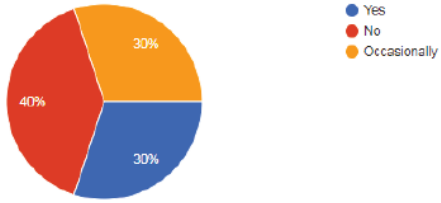

20) Do you believe that responsible e-waste disposal can help mitigate environmental pollution? Copy

10 responses




21) Are you actively involved in recycling electronic devices or e-waste in your daily life? Copy

10 responses



22) Have you ever recycled electronic devices or e-waste at a recycling center?

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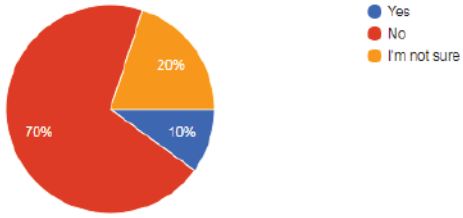
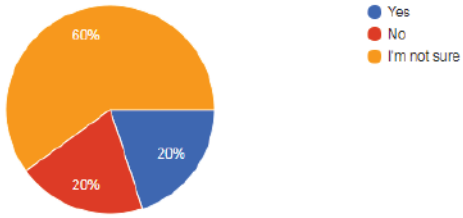
10 responses




23) Do you believe that most people you know dispose of electronic waste responsibly?

Copy

10 responses




24) In your opinion, does your local area have adequate e-waste recycling infrastructure?

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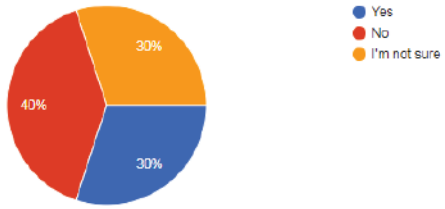
10 responses




25) Do you think that governments and businesses should invest more in e-waste recycling infrastructure?

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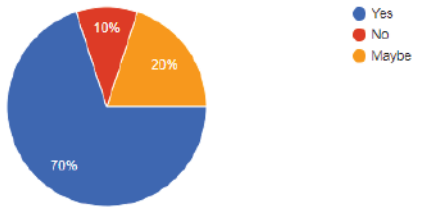
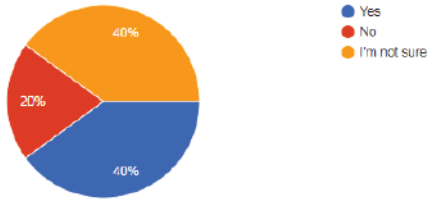
10 responses



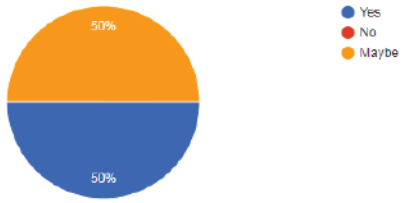
26) Are you aware of any health risks associated with improper e-waste disposal? Copy

10 responses



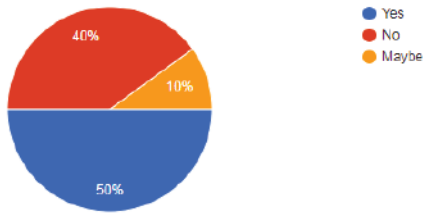

27) Do you think that individuals working in e-waste recycling face health hazards? Copy

10 responses



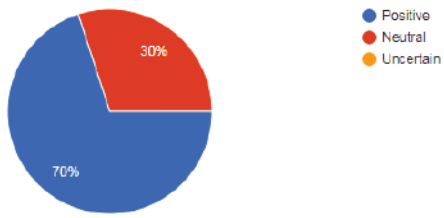

28) Have you ever participated in or supported local e-waste recycling initiatives or awareness campaigns? Copy

10 responses




29) How do you envision the role of e-waste recycling in building a more sustainable future? Copy

10 responses



## 3. Results and Discussion

The use of efficient logistics and transport systems resulted in greater outcomes for segments. Inventory improvements resulted in better stock levels, reduced overruns, and more efficiently meet demand. This reduced freight costs and improved revenues. Interconnectivity between suppliers, manufacturers and distributors through improved supply chain management has greatly simplified processes to reduce lead times and improve overall efficiency to the sky

The selection of appropriate delivery methods based on quality and urgency facilitated timely delivery while keeping costs under control. GPS inspection, integration of technology of Inventory Management Software etc. Honesty and accidents increased accidentally, which has been a few problems with dissolving but problem-solving including elevation solutions and essay reducing the neighbors in the case.

Discussion on the outcomes revealed a marked reduction in logistical complexities and progressed supply chain reliability. Notably, the incorporation of technological improvements notably better real-time tracking abilities, offering valuable insights for proactive choice-making. Additionally, the optimized transportation modes and streamlined tactics minimized transit instances, improving purchaser pride by using ensuring prompt deliveries.

Furthermore, the implementation of hazard management techniques appreciably mitigated ability disruptions, safeguarding against delays and damages. This comprehensive approach no longer simplest expanded operational resilience but additionally strengthened the device's adaptability to unexpected demanding situations, enhancing usual robustness.

An vital element highlighted within the dialogue became the superb effect on sustainability. By optimizing transportation routes and adopting green practices, the device correctly reduced the carbon footprint, aligning with environmental desires and enterprise standards.

Overall, the results and next discussion underscored the significant enhancements achieved thru an integrated goods management and transportation device, showcasing stepped forward efficiency, reduced costs, greater client satisfaction, and a commitment to sustainable practices.

## 4. Conclusion and Recommendation

In conclusion, the implementation of a Goods Management and Transportation System brings numerous benefits to organizations involved in managing and transporting goods. The system enhances operational efficiency by streamlining processes, optimizing resource utilization, and reducing manual effort. It improves accuracy through precise data capture and real-time updates, minimizing errors in inventory management, order fulfillment, and tracking. The system also provides end-to-end visibility, enabling better monitoring and decision-making across the supply chain. With faster order processing, improved customer service, and cost savings, customer satisfaction is increased. Compliance with regulations and industry standards is ensured, mitigating potential legal risks. The system generates valuable insights through comprehensive reporting, facilitating informed decision-making. Scalability, collaboration, and risk management are further improved, contributing to a streamlined and effective supply chain. Overall, the Goods Management and Transportation System empowers organizations to achieve higher efficiency, accuracy, customer satisfaction, compliance, and profitability in their goods management and transportation operations.

## 5. Reference

S. A. Shobha Rani, A. N. Siddharth, and K. Ravikanth Reddy, "A review on smart parcel management system using Internet of Things," 2019 IEEE International Conference on System, Computation, Automation and Networking (ICSCAN), 2019, pp. 1-6. 2.

Y. Zhang, L. Cheng, and J. Liu, "A cloud-based smart parcel management system for urban logistics," 2017 IEEE International Conference on Service Operations and Logistics, and Informatics (SOLI), 2017, pp. 1-6.

# Security Application System for Women

**Thushigha Srishantharuban[1], Anis Saboordeen[2]**

*[1]Solent University, United Kingdom.*
*[2]British College of Applied Studies, Sri Lanka.*

## Abstract

Traveling alone is never safe in today's society, and women's security is a growing topic of concern. Every girl's top concern in the current world is for their safety and the problem of harassment. Every girl's one constant thinking is about the day they will be allowed to walk the streets freely at all times without having to worry about their safety. To provide women a sense of security when they go outside, I create an app. This software ensures the protection of women. Recognizing and making use of resources can help you escape dangerous situations. These decrease the risk and offer assistance when girls are in danger, allowing us to communicate our position to the individuals we need to call. The Application is a web-based and mobile application. Many headlines still depicting violence against women imply that harassment and other forms of sexual assault are on the rise in our day.

## Extended Abstract

### 1. Introduction

In today's world, where the safety of individuals, especially women, is a growing concern, the need for innovative solutions has never been more crucial. Traveling alone can be a daunting experience, and women often find themselves constantly worrying about their safety in various situations. Harassment has become an unfortunate reality, prompting the urgent need for tools that empower women and provide them with a sense of security.

Understanding the pervasive nature of this issue, I have developed an app aimed at addressing the safety concerns of women. The app, available both as a web-based platform and a mobile application, is designed to offer protection and assistance to women when they venture outside. It acknowledges the importance of recognizing and utilizing available resources to navigate potentially dangerous situations effectively.

The central idea behind this app is to mitigate risks and facilitate communication in times of distress. By leveraging technology, it allows users to share their real-time location with trusted contacts, ensuring swift assistance when needed. The ultimate goal is to create an environment where women can confidently walk the streets without the constant fear of harassment or harm.

In a world where headlines continue to highlight incidents of violence against women, this app stands as a proactive measure to counteract the rising trends of harassment and sexual assault. By combining technology with a commitment to women's safety, the app strives to contribute to a future where every girl can experience the freedom of movement without compromising her security.

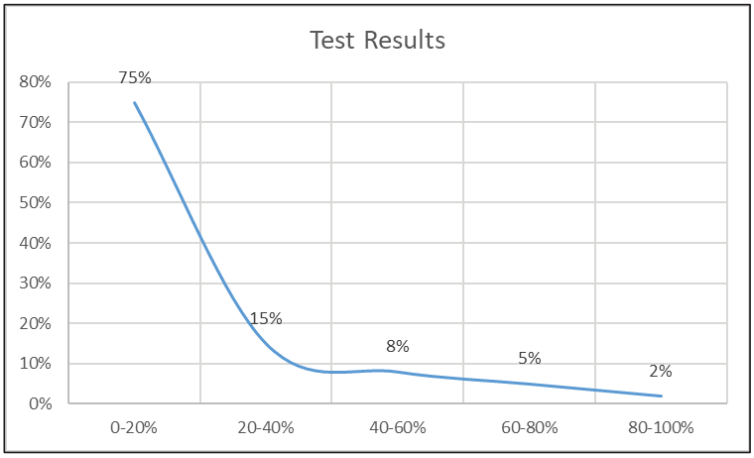
## 2. Methodology

The secondary research approach is the foundation of this study. The term "secondary research" refers to analysis of existing systems. The best proposals for the system are found via numerous analyses of the current systems. The suggested system's analysis of the tools utilized for women's security application systems. Using qualitative and quantitative research methods, I implemented the two testing tactics previously indicated to the women security application system. I used a qualitative analytical strategy to gather my data, which includes interviews, group discussions, face-to-face conversations, and literature reviews. I prepared a few questions for the face-to-face discussion and posed them to the participants. Here, I learned how to defend women and how to put that information into practice. To get feedback that may be utilized to improve the system, I held a group discussion about the women's safety application system. I studied the literature review and the survey of other writers' published works. During this interview, I acquired some information for my study on a women's security application system. Using an online survey, I collected data using the quantitative analysis method. I just conducted an online survey, and many people participated. And because the results are almost always positive, it is obvious that the research methods used to ascertain people's opinions on this system are trustworthy and accurate enough to move the project forward.

Primary data is any unique information you collect to address a research question. I gathered primary information through in-person discussions, focus group discussions, observations, interviews, surveys, and questionnaires. Project implemented through the agile model to create the project Women Security Application System. This concept eliminates the flaw in the waterfall model. Once the work begins, teams cycle through a process of planning, executing, and evaluating. Some steps are doing one after the other and some steps are done parallel, that means did some steps while doing another task. In software testing methodology, System tested through Integration testing, System testing, and Acceptance testing are the levels applicable to the black box testing. Integration testing is a methodical testing process used to build software architectures in which the system is tested after each item has been integrated and also tested via Unit testing is the level of white box testing. A set of requirements must be met by the system; therefore testing is done to validate. Test Artifacts are the deliverables that are given to the stakeholders of a software project. Women Security Application System which follows agile methodology undergoes the different phases before delivering to the customer. Artifact like Product backlog, Sprint backlog and Product increment created. There is also other artifact maintained like burned down chart. Some of the deliverables are provided before the testing phase commences and some are provided during the testing phase and the rest after the testing phase is completed.

## 3. Results and Discussion

The aim of this project is to provide awareness on the time of critical situations for women and this app can be activated by a single click, whenever need arises. Objectives are to send the alert message and share the live location to the registered contacts and guardian continuously, to do call, voice recording, and photographs, and transfers these to the police and registered contacts as well, to send Automatic alert when panic situation, to Search a police station from their nearby location and to View the updated women's awareness seminar videos and news. This research presents the overall design of the Women Security Application System. In this System which has 3 interfaces which are Admin, Police and User. Anytime a need occurs, this Application for the Safety of Women and this app may be launched with a simple click. This program only one click to pinpoint the location and storing the details of the current location share consecutively. Sends the contacts who have been added an SMS message with this location, calls the first contact who has been added, and calls the police to help the person in need. Search a police station from their nearby location. It is easy to make a complaint about an emergency occasional situation. View the updated women's awareness seminar videos and news. It helps to protect the women. Advantages are The System is user friendly, cost effective, backup support, secured Data, helpful for women security.




Above present the results that address this specific hypothesis question first. The findings that firstly address this particular hypothesis question are shown above. "Women Security Current Satisfaction?" is the hypothesis. In this instance, possibly a line graph displaying survey data. This graph can include the response percentage. A line graph is used to depict correlation matrices, probabilities, and standard deviations. Pay careful attention to experimental findings and other discoveries that are extremely relevant to your questions as I develop objectives and use them to support my hypotheses. The Results section provides the essential details as a representation of the data output from the hypothesized inquiry. 75% of working women report feeling insecure. Therefore, we are developing this application and intend to widely implement it in order to lower this rate, significantly alter society, and safeguard women from all crimes. One of the key steps in achieving gender equality is providing women with safety and security.

## 4. Conclusions

Finally, come to the conclusion This project highlights the use of a web-based women's safety app that was created with the help of current advancements in technology. There are several ways to reduce crimes including homicide, kidnapping, harassment, and molestation. The best strategy to ensure women's safety at this time is location-enabled communication. The location information associated with the admin account may eventually be obtained in order to carry out the legal procedure to have the offenders arrested. The difficulties will be resolved by the designed design, which will prioritize the security of women. This implementation of the Application is to ensure the safety of women. The project is completed in various phases which include different modules. In the login module, I provide three types of registrations, one for users and one for police, and one for guardian. The information from this module is further used in the login module which requires an id and password to login into the application. In the next module have given an SOS button. The SOS button has various functionalities. It is used to send panic messages and location links to the guardian's cell phone. Therefore, after pressing the SOS button, the updated location coordinates will be sent to the registered phones as well as any local police stations. This application provides the necessary safety and security to any individual who might face social threats and can prove to be a useful tool for women's safety and empowerment. This project has room for growth in the future. Every day, new techniques and technologies are developed for use in computers. It is not static; it is dynamic. In a few days, the popular talents of today will be obsolete. The system might also be enhanced in order to stay up with technological advancements. As a result, it remains open. However, it will get better with more upgrades. It is possible to make improvements in an efficient way. Even the same with additional alterations and can be incorporated with little change. As a result, the project is adaptable and can always be enhanced with more modern features.

## 5. References

The global assessment on women’s safety - preventionweb (no date). Available at: https://www.preventionweb.net/files/13380_7380832AssesmentFinal1.pdf (Accessed: September 10, 2023).

(no date) Ask questions about women's safety in the city. Available at: https://www.endvawnow.org/en/articles/262-ask-questions-about-womens-safety-in-the-city.html (Accessed: September 10, 2023).

# "Lazy Botanist"

# Automated Home Gardening System for Sustainable Wellbeing

**A. A. Ilham[1], Anis Saboordeen[2]**

*[1]British College of Applied Studies, Sri Lanka.*
*[2]British College of Applied Studies, Sri Lanka.*

## Abstract

In today's technologically advanced world, IT support is visible in many different fields, but agriculture is less explored. By ushering in a new era in agriculture and making it accessible and appealing for everyone, our project aims to close this gap. Our automatic home gardening system aspires to simplify agriculture in the same way that IT advances have simplified difficult tasks. Our project is an effort that aims to meet farmer requirements by promoting farming activities across the globe. Our solution promises to make agriculture more dynamic and manageable by utilizing the power of the Internet of Things (IoT). It ensures long-lasting durability by providing premium performance and components in a small design. Our concept reimagines home gardening by incorporating the most recent technology to make it easier and more pleasurable. By using IoT, we reduce our workload and save time, money, and energy.

In essence, our automated system for home gardening applies IT innovation's benefits to the agricultural industry, paving the way for a better, more sustainable future where people from all walks of life can actively engage in gardening, promoting both environmental wellbeing and personal fulfillment. This automatic home gardening system enhances sustainability by optimizing resource usage, reducing waste, and promoting efficient, eco-friendly practices. It doesn't merely grow plants; it cultivates a sense of environmental responsibility and a deeper connection with nature.

## Extended Abstract

### 1. Introduction

Introducing my project "Automated home gardening system for sustainable wellbeing". It is a prototype which I have created that helps to make the process of home gardening possible with much ease. The whole goal of this project is to make sure that here is less human interaction with the pattern, which is the automated home gardening system, but all the functions should be functioning as mentioned. It helps to automate the process of gardening, watering the plants with high accuracy soil moisture sensors and mini rainwater tank setups to pump the water. The tanks have water level readings to make sure that it doesn't overfill and if it does, it will close the doors for the tank. It has automated rain sensors to detect the rainwater and open the tanks which can protect it from other kinds of debris entering the tank. Automated smoke and fire detection setup has been implemented so if the sensor detects any kind of smoke or fire, it will set the alarm and automatically draw water from the tank and dispense it. Parallelly, it has Bluetooth setup connectivity attached as a backup plan for the system making it an efficient way to have a garden setup at the comfort of your home with ease.

## 2. Methodology

Our initial step in carefully designing and developing our Automatic Home Gardening System with IoT Integration was to construct a thoughtful system architecture and carefully plan the links between the various components. This was done with a strong emphasis on making sure that each component worked perfectly together and seamlessly. The Arduino Nano is used for programming modules, while the Arduino Uno acts as the main controller, managing the entire system. These two Arduino boards form the basis of our system.

The L298N motor driver is in charge of managing the motors in charge of both the greenhouse gate and the tank in order to improve automation and security. The Arduino-controlled automatic greenhouse gate is Bluetooth-enabled, ensuring simple accessibility and increased convenience. The Soil Humidity Hydro Meter, an advanced soil moisture sensor, efficiently automates the watering process for accurate plant care. This method of resource management is activated when soil moisture levels fall.

In order to ensure protection and safety we have integrated sprayer systems to put out any possible risks in the event of fire or smoke detection. In the case of a fire outbreak, a backup 5V buzzer serves as a warning signal and notifies nearby residents. The water level meter, which is made up of LEDs and 220-ohm resistors, automatically shuts off the tank's intake once it is full, while the 5V DC water pump effectively takes water from the tank to satisfy the needs of the gardening system.

A rain sensor that detects precipitation and sends it to the tank is another way that our system adopts sustainable practices. This promotes water saving. Three 9V batteries are used to provide power, providing continuous operation. We've implemented an HC-05 Bluetooth module as an extra layer of security to ensure system control in emergency scenarios, which can be easily carried out using an easily accessible mobile application from app stores. Our concept, which will revolutionize home gardening through cutting-edge technology and environmental methods, depends on the peaceful operation of these slowly coordinated parts.

## 3. Results and Discussion

As I have proposed, I accomplished my goal in creating the prototype as I have explained it. A few changes were added to the structure of the base along the way. Down below are some sample images of the prototype:

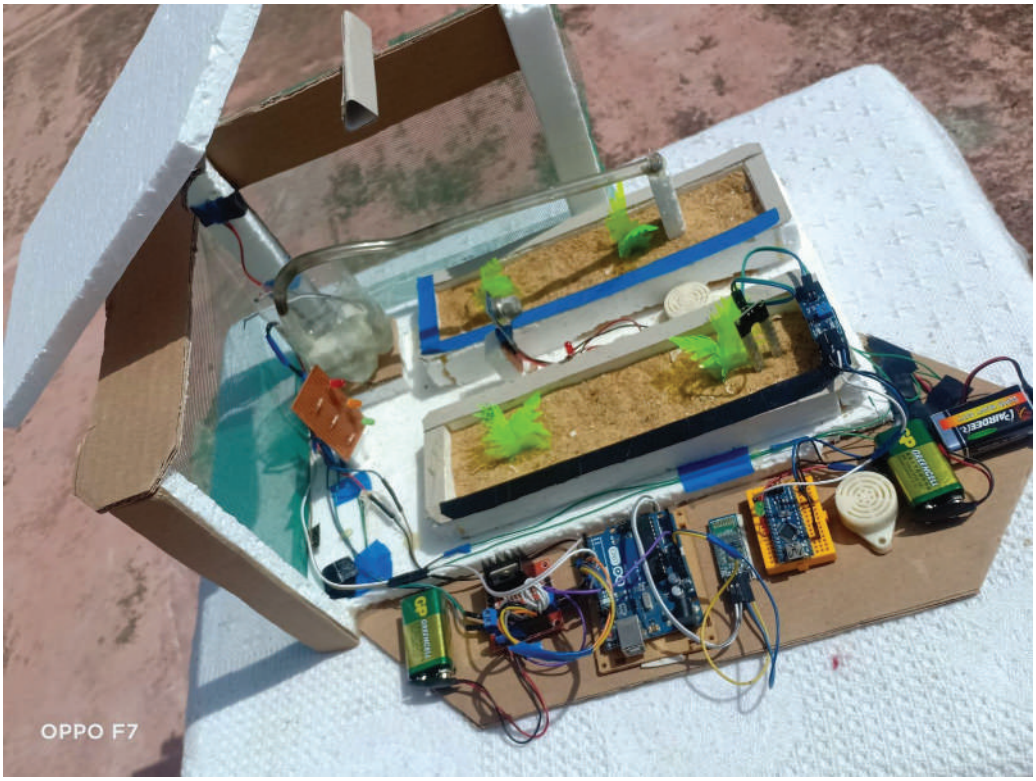



*Figure 1 Complete project image*

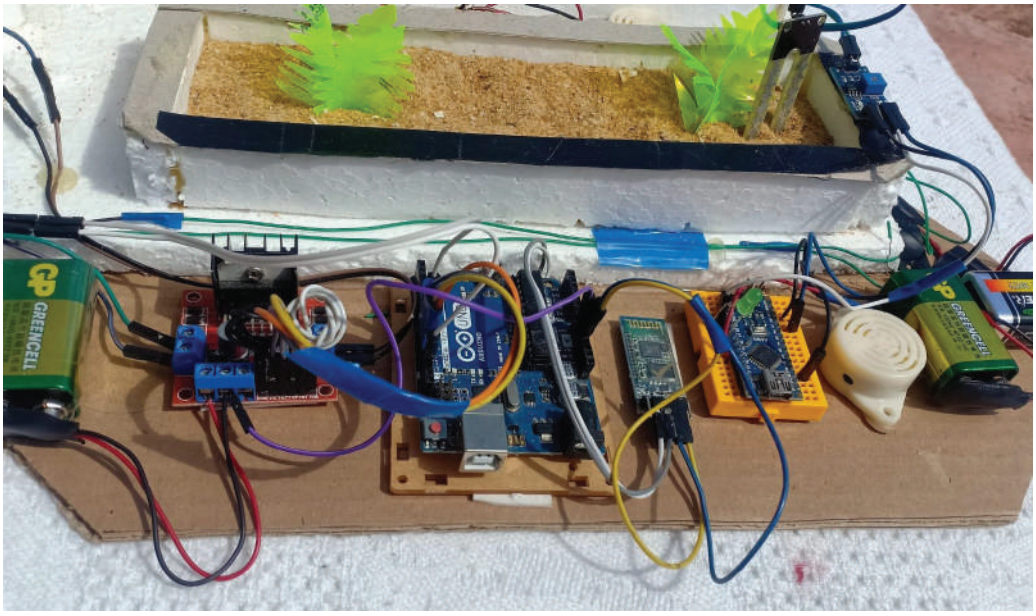



*Figure 2 Control panel*

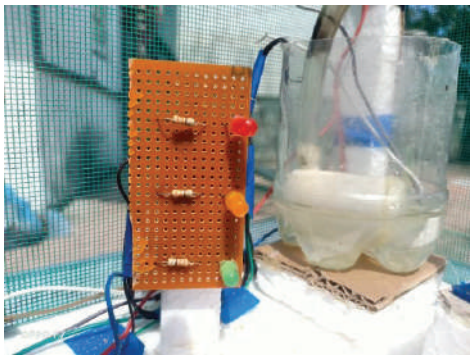


*Figure 4 Water level meter and tank setup*

*Figure 3 Tank cover.*

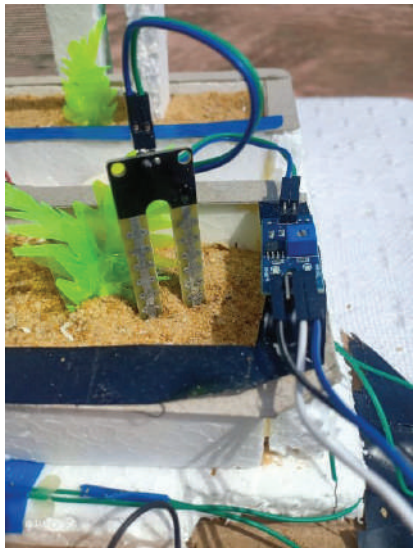


*Figure 5 Soil hydro meter setup*

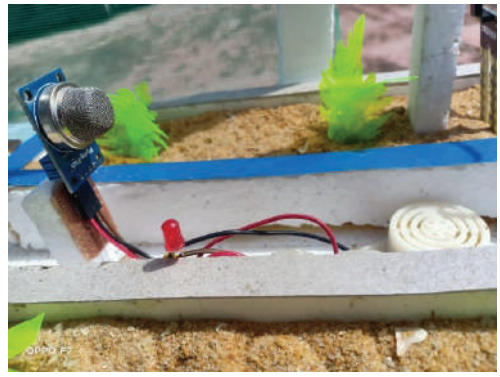


*Figure 6 Smoke and fire detection setup*

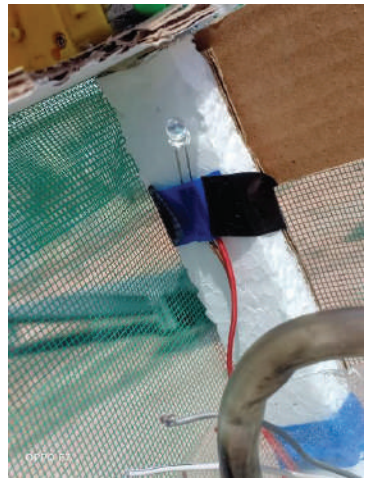


*Figure 7 Lighting system for the project.*

## 4. Conclusions

Modern gardening techniques have entered a new age with the adoption of the Automatic Home Gardening System with IoT Integration. By merging cutting-edge technology, this creative system completely transforms the way we approach gardening. It was carefully created and put together.

By automatically monitoring and watering the soil, the system excels at guaranteeing optimal plant health and resource efficiency. This clever strategy reduces the dangers of both overwatering and underwatering, providing a comprehensive answer for plant care. A further level of security is added to the garden environment's safety by the incorporation of fire detection and prevention features.

With a rain sensor and a mechanism to collect rainwater, this system places an intense focus on environmental responsibility. Rainwater collection and reuse for irrigation is in line with environmentally friendly gardening methods.

The system's ability to be controlled remotely using a mobile application is one of its unique characteristics. Along with increasing ease, this encourages flexibility in garden management so that it can fit around the user's busy life.

The Automatic Home agriculture System with IoT Integration is an example of how technology has the power to completely transform agriculture. It facilitates resource-saving and environmentally responsible methods while streamlining the gardening process. This endeavor serves as proof of the advantages of technological innovation in gardening.

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# "Green Data Centres" Green Data Centre Reducing Carbon Emissions

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## Abstract

This study explores the topic of green data centres, focusing in particular on its applicability in Sri Lanka. This study's main objective is to assess the benefits and difficulties of setting up and running environmentally friendly data centres in the context of Sri Lanka. The study acknowledges the advantages of green data centres, such as decreased energy use, financial savings, and a smaller environmental impact. These data centres demonstrate their viability on an economic and environmental level by utilizing energy-efficient technology, improved cooling systems, and renewable energy sources.

Establishing green data centres in Sri Lanka offers numerous advantages, but it also comes with challenges and opportunities. The challenges primarily involve the high initial costs and the need to manage computing demands with limited resources. However, there are opportunities in leveraging renewable energy, implementing efficient cooling methods, and adhering to international standards for eco-friendly data centres. It is crucial for the Sri Lankan government to play a vital role by enacting supportive regulations and policies to facilitate the growth of green data centres. Taking a holistic approach that incorporates renewable energy sources, efficient cooling systems, and international best practices is recommended for designing, constructing, and maintaining these data centres.

Although specific instances of green data centres in Sri Lanka were not identified, this research draws insights from global case studies that emphasize the significance of power management, energy efficiency metrics, and sustainable practices. This study not only enhances our understanding of the importance of green data centres but also highlights the necessity for collaborative efforts among the government, businesses, and international organizations to foster sustainable and energy-efficient data centre solutions both in Sri Lanka and beyond.

## Introduction

This study's research approach is to thoroughly examine the energy effectiveness and environmental impact of green data centres. The project will use surveys, interviews, and case studies to collect information from industry experts, data centre operators, and other stakeholders using a combination of qualitative and quantitative methodologies. In order to consolidate current information and identify any gaps in our understanding of green data centre practices, a literature review will also be done. (marketsandmarkets, 2021)

The project's scope includes a comprehensive analysis of green data centres with a particular emphasis on methods and tactics for increasing energy efficiency and minimizing the effects of global warming. The study will investigate a number of topics, including hardware improvement, control of electricity and cooling, and the use of environmentally friendly methods in data centres. The geographical scope mostly entails a worldwide viewpoint, but it could also contain particular case studies, like those in Sri Lanka, to give a more nuanced understanding. (imarcgroup, 2023) While attempting to provide thorough coverage, this study does have certain limitations. Biases present in survey and interview data may affect the information gathered. Furthermore, certain discoveries can become out of date due to the technology's quick evolution. The scope of the study may also be limited by constraints such as time and resource availability. Report Organization: The report will be divided into various sections for greater readability and clarity. These will include an introduction, a review of the relevant literature, the research methodology, the findings and analysis, the discussion, and the conclusion. Each part will help to create a coherent story that answers the study's goals.

A worrying pattern that has developed over time is shown in the graph showing Sri Lanka's carbon emissions. Carbon emissions in the nation have been steadily increasing since 1960, reaching a peak of 25,510,660.000 metric tons (KT) in 2019. But in 2020, when carbon emissions fell to 23,862.51 KT, there was a noteworthy and considerable difference. The COVID-19 pandemic outbreak, which significantly reduced economic activity and travel, is largely responsible for this sudden decline.

The main contributor to carbon emissions in Sri Lanka is the combustion of fossil fuels, which include coal, oil, and natural gas. These fossil fuels contributed significantly to the nation's overall carbon emissions in 2021, making up 82% of the total. Land use changes and cement manufacturing emissions are additional major issues. As a major contributor to the ongoing problem of climate change, the upward trend of carbon emissions over the past few decades are cause for alarm. The negative effects of climate change are already being seen in Sri Lanka, where there has been a rise in extreme weather phenomena such storms, floods, and droughts.

The Sri Lankan government has pledged to reduce carbon emissions in light of the seriousness of the situation. By 2050, they aimed to have net-zero carbon emissions, which they did in 2021.

The government intends to do this through strategically investing in renewable energy sources, improving energy efficiency throughout diverse industries, and reducing deforestation. There are a number of crucial steps that can be performed to actively reduce carbon emissions in Sri Lanka. As a viable substitute for fossil fuels, the nation can first increase its reliance on clean energy sources like solar and wind power. Prioritizing energy efficiency measures in the construction and transportation sectors can also result in sizable savings.

Literature Review

Green data centres that encourage energy conservation and address unsustainable living are being established in response to the urgent national demand for sustainability. In order to make better management decisions, this endeavour entails building energy-efficient data centres and implementing a Decision Support System (DSS). This research is important for both the academic community and business since it has the potential to significantly increase energy efficiency. Demand rationalization, supply optimization, and organizational enablers are three crucial levers that are identified, together with several energy efficiency scenarios, to achieve data centre efficiency. Estimating power use is difficult, though. The DSS, a computer-based tool, is essential to data centre architecture because it guarantees continuous operation, uses decision trees to lessen uncertainty, and makes use of metrics for automation and benchmarking.

A revolutionary answer to the urgent national demand for sustainability is the creation of green data centres and the related Decision Support System (DSS). These programs utilize supply optimization, demand rationalization, and organizational enablers to increase data centre efficiency. The DSS, a vital tool, uses data analysis and subject-matter expertise to speed up decision-making across a range of industries and ensure continuous data centre operation. Improvements to virtualization, decision trees, and Energy Star-rated servers are all essential elements. This study is significant on a national and international level, and it also emphasizes the need to increase political will, knowledge, and capacity in order to make a sustainable transition.

Due to the rapid advancement of computing technology and the quest of peak performance, the energy demand for the data centre industry is rapidly rising. Various strategies and methods are being used to improve energy efficiency in data centres as a response to this. The use of green metrics to cut back on power and cooling expenses, the optimization of data storage, and the reduction of physical servers are a few of these strategies. Green data centres are essential for sustainable development, cost reduction, and energy conservation. But it's difficult to balance the expanding need for computing capacity with existing power, cooling, and space constraints.

Over the past 30 years, the data centre sector has developed in a way that has been characterized by efforts to match efficiency with various infrastructures. The 30-year growth of the present green movement, which emphasizes the harmony between ecological practices and economic

prosperity, reflects this transition. In order to achieve sustainable development, businesses must strike a balance between rising processing demands and environmental limits. The achievement of carbon neutrality through quantifiable measures is the ultimate objective of green data centre operation. The effect of IT on the environment must be addressed because the industry's energy use exacerbates existing environmental problems. Given the past poor development compared to performance and cost improvement, increasing energy efficiency in computers is essential in addressing these challenges.

The need for fossil fuels and rising global population both contribute to global warming, which has serious effects including melting polar ice and rising sea levels. Global efforts have been made to cut greenhouse gas emissions as a defines against this. Green data centres are essential to this project since they concentrate on lowering the carbon footprint of computer technology. The energy efficiency and environmental impact of these facilities are maximized. Examining energy efficiency indicators like PUE and DCIE, adopting scalable IT hardware, and switching to high-efficiency power sources are all part of the journey to green data centres. Companies are encouraged to cut back on their energy use, and recycling old equipment has both financial and environmental advantages. With a focus on the value of power management and energy-efficient technology, major industry companies like IBM and Dell have started energy reduction initiatives. It's more important than ever to manage electricity needs and sustainability as the data centre business expands.

The concept of "green data centres," where energy-saving measures and sustainability play a crucial role, has emerged in response to the urgent need to battle global warming. Government certifications and regulations, which encourage green building, are the driving forces behind these facilities. Because data centres have a high energy requirement, energy efficiency is a major issue that raises concerns about operational costs and environmental effects. There are still issues with data centre power management, which highlights the need for standardized measures and government-university research partnerships to create best practices. Reassessing energy efficiency metrics, using scalable IT hardware, and emphasizing power control are all required while making the switch to green data centres.

Green data centres with the highest levels of energy efficiency are required due to the urgency of the environment. Power and cooling use are directly impacted by the expansion of data storage, with significant carbon footprints as a result. Green data centres must implement standardized energy performance measures and energy-efficient strategies to address this. In order to cut electrical expenses, managers and operators of data centres must work together. Additionally, eco-friendly data centre procedures are supported globally by industry standards and laws. The promotion of sustainability and energy-efficient improvements in data centres is the subject of programs like LEED and other publications. Protocols for measuring server energy and knowledge

of server power usage aid in effective energy management. In order to reduce the environmental impact of data storage and assure a sustainable future, the switch to green data centres is essential.

Comparison and Contrast of Green Data Centre Articles

The papers as a whole highlight the growing significance of green data centres in addressing environmental issues and the rising energy demand of the data centre industry. According to Rick Bauer's article "Building the Green Data Centre Toward Best Practices and Technical Consideration," energy conservation and sustainability are urgently needed to combat global warming. It shows the continued difficulties in data centre power management as well as the crucial role played by government rules in promoting the construction of green data centres. The importance of revising energy efficiency metrics, adopting scalable IT gear, and giving power control top priority is emphasized as part of the move to green data centres.

In comparison, Ramon Mata-Toledo and Prance Gupta's "Green Data Centres" discusses the broader context of global warming and attributes it to the increasing demand for fossil fuels and a growing global population. The article connects the importance of green data centres to the overall goal of reducing the carbon emissions produced by computer technology. It emphasizes the examination of energy efficiency indicators, the adoption of scalable IT hardware, and the transition to high-efficiency power sources as crucial steps in achieving green data centres. Furthermore, the article highlights the efforts made by industry leaders like IBM and Dell to reduce energy consumption, emphasizing the growing significance of managing electricity needs and sustainability as the data centre industry expands.

Mueen Uddin and Azizah Abdul Rahman's article, "Techniques to implement in green data centres to achieve energy efficiency and reduce global warming effects," focuses on specific strategies and methods used to improve energy efficiency in data centres. The article acknowledges the challenges posed by the rapid advancement of computing technology and the need for optimal performance. It advocates for the use of green metrics, data storage optimization, and the reduction of physical servers. The article recognizes the pivotal role played by green data centres in sustainable development, cost reduction, and energy conservation. It also highlights the delicate balance required to meet the growing computing capacity demands within the constraints of power, cooling, and space available.

Considering growing environmental concerns and rising energy needs, these articles show how the data centre sector has evolved toward green practices overall. The crucial significance of energy efficiency, the adoption of sustainable technology, and the function of green data centres in reducing the environmental impact of computing are all emphasized in the articles, even if each one offers distinct insights. Collectively, the studies emphasize how important it is for business,

academia, and government to work together to create standards and best practices for building sustainable and energy-efficient data centres.

Research approach and methodologies

Technique using both qualitative and quantitative research methodologies, known as mixed methods, would be suited for studying green data centres. A nuanced examination of stakeholders' opinions, difficulties, and experiences with adopting green data centre practices would be possible with qualitative research methodologies including in-depth interviews and focus groups. Understanding the motivations behind and obstacles to the adoption of sustainable data centre solutions by enterprises can be facilitated by qualitative methodologies. Additionally, qualitative research can shed light on the cultural adjustments necessary for successful adoption of green data centre projects by offering insights into the socio-cultural components of those initiatives.

The efficiency, energy savings, and environmental impact of green data centres can be quantified via surveys and data analysis, which can also help collect structured and numerical data. Quantitative approaches are crucial for evaluating the observable effects of green data centre activities, such as decreases in energy use, cost savings, and greenhouse gas emissions. It will be possible to fully comprehend the complex nature of the implementation of green data centres by combining qualitative and quantitative methodologies.

The research, rules, design strategies, case studies, and final report are all covered in this table's list of the major activities and deadlines for the preliminary plan. By October 16th, 2023, the project should be finished, with the report and conclusion outlining the research on green data centres and their applicability to Sri Lanka.

## Conclusion

The exploration of green data centres and their applicability in Sri Lanka has uncovered both their major benefits and major drawbacks. There are several advantages to constructing and running environmentally friendly data centres in Sri Lanka, but energy efficiency and cost savings are the two main ones. These green data centres offer a more dependable energy source for crucial activities, which helps reduce the burden on the country's power grid. The benefits to the environment and long-term cost reductions surpass the initial expenditures, notwithstanding the possibility of a greater initial investment. Green data centres are a beacon for drawing enterprises seeking to lower their carbon footprint and foreign investments since the growing interest in sustainable practices fits with global environmental goals. Despite Sri Lanka's lack of particular laws governing green data centres, the country's more general energy and environmental policies implicitly encourage their expansion. Sri Lanka should think about creating particular rules and

incentives to encourage the use of green data centres in order to hasten the adoption of these techniques.

The study emphasizes how crucial it is to give energy efficiency, renewable energy sources, and climate-adapted cooling systems top priority when designing, building, and operating green data centres in Sri Lanka. It is essential to speed this shift by working with international organizations and utilizing global best practices. While there may not be many specific instances of green data centres in Sri Lanka, Sri Lanka's transition to greener data centres will be greatly aided by studying international examples and realizing the advantages of cost savings, environmental protection, and energy conservation. The viability of green data centres in Sri Lanka will ultimately depend heavily on the country's commitment to sustainability and environmental responsibility.

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# "AI-Powered Interactive English Learning Platform for Primary Students"

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## Abstract

The COVID-19 pandemic has disrupted the education system, forcing schools to close, and limiting student-teacher interactions. Combined with economic challenges, many families struggle to manage school-related expenses. This disruption particularly impacts primary students, who lack the skills for independent study.

Despite these challenges, the need for proficient English education, especially in rural areas, remains crucial. Urban schools have tools like visual aids and audio-visual equipment to enhance learning, but rural educators lack these resources, hindering interactive English teaching.

In response, we propose an online solution using computer vision and natural language processing (NLP). These technologies, integral to artificial intelligence, enable the system to interpret visual content and understand human language, providing a robust platform for interactive English lessons.

## 1. Introduction

Sri Lankan graduates limited English proficiency affects their employability both locally and internationally. Even though English has been emphasized in Sri Lankan schools since the 1950s, the English literacy rate is only 22% for those below ten years old. The COVID-19 pandemic, confirmed by studies from the University of Bedfordshire and the charity School readers, has worsened literacy levels among primary students.

Economic instability in Sri Lanka, combined with the pandemic's disruptions, puts education, especially for underprivileged primary students, in jeopardy. Rising costs and a fuel crisis make additional tuition less accessible for many families.

In today's global context and considering Sri Lanka's challenges, enhancing English proficiency is crucial. This project addresses these literacy gaps by supporting educators and students through digital tools. An image-based Q&A approach can create a more engaging and interactive English learning environment.

Mastering English is a significant challenge for many primary students in Sri Lanka, largely due to limited resources. Many schools don't have dedicated English teachers, and some employ non-specialized instructors, leading to inadequate teaching. Varying class sizes hinder tailored education, making it hard to address individual needs and discouraging students from furthering their English studies.

Parental support is inconsistent. While some parents lack proficiency, others don't have the time. The economic downturn and fuel crisis have made hiring private tutors or seeking additional lessons increasingly challenging.

Traditional teaching methods have diminished students' enthusiasm for learning English. A shift towards engaging digital tools, like voice communications and interactive Q&A imagery, can rekindle interest and alleviate educators' challenges.

## 2. Methodology

A comprehensive evaluation strategy is essential to assess the efficiency, usability, and overall educational impact of the AI-Powered Interactive English Learning Platform for Primary Students. This section outlines the approach to guide, evaluate, and refine the platform based on literature sources, feedback, testing results, and analysis.

### Dataset Collection

Online Data Repositories: Making use of renowned online platforms such as Kaggle, which hosts a myriad of datasets tailored to diverse needs. For this project, datasets pertaining to English language learning, image recognition, and Q&A systems are particularly interesting.

Specialized Datasets

- FairytaleQA: For its narrative style, which is suitable for primary students.
- SQuAD (Stanford Question Answering Dataset): Essential for understanding and modeling Q&A systems.
- TriviaQA: Offering a range of general knowledge questions that can help in enhancing the students' language comprehension.
- COCO (Common Objects in Context): It provides images with context, aiding in visual recognition and comprehension tasks.
- Flickr30k: Beneficial for its image-caption pairs, bridging the gap between visual content and textual description.
- VQA (Visual Question Answering): Directly relevant as it merges the domains of visual content with language processing for Q&A tasks.

### User Feedback Collection

Surveys: Develop detailed questionnaires tailored for students, teachers, and parents to assess usability, learning impact, and potential improvements.

Focus Group Discussions: Conduct sessions with small groups to derive in-depth insights into user experiences and challenges.

## 3. Development Methodology

Leveraging Natural Language Processing, we intend to convert teacher-uploaded English paragraphs, adhering to the grade 3 curriculum, into a series of questions. The designed approach emphasizes comprehension, asking students to extract answers from the text. Anticipated answer formats include yes/no, numeric, or single-word responses.

*Figure 1: Sample questions based on the paragraphs.*

**Image-based Question Generation**

Our solution introduces an innovative image-based question-answering system, capitalizing on advancements in deep learning. Tackling this interdisciplinary challenge by combining vision and language, the system generates questions that explore different image facets. Teachers upload images, and the system produces questions, particularly about prepositions. The student's role is to interpret the image, and its context, and answer accordingly, often in single-word format.

*Figure 2: Sample Image-based question*

### Sentence-to-Image Matching

For this module, sentences are dynamically formulated based on images. These sentences are then jumbled and presented alongside a collection of images. Students engage by correlating the sentences to the respective images, fostering English comprehension through this pairing activity.

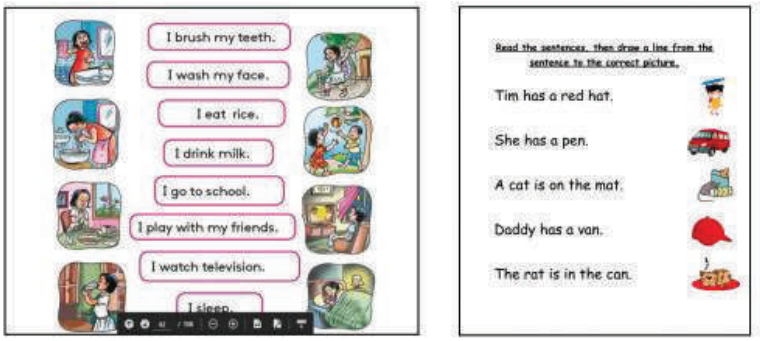
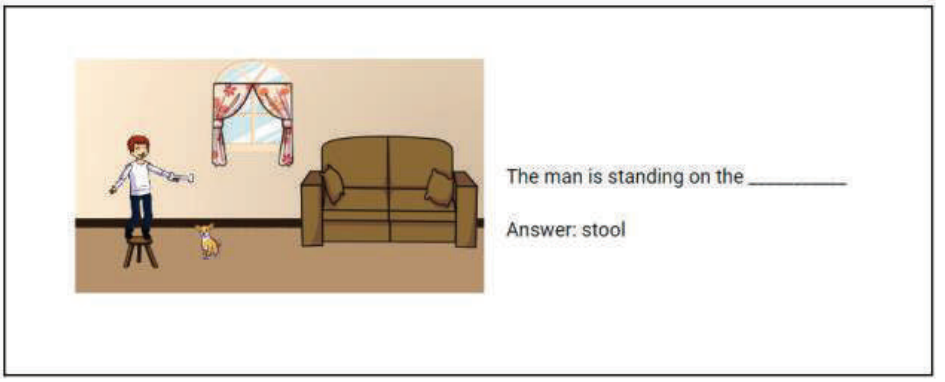



*Figure 3: Examples of Sentence-to-Image Matching*

### Image-driven Fill-in-the-Blanks

Images uploaded by teachers serve as a foundation for creating fill-in-the-blank sentences. Students interpret the images and corresponding sentences, deducing the missing terms. The challenge is limited to a five-word cap, ensuring alignment with the grade 3 curriculum.



## 4. Conclusions

In this project progress report, I've comprehensively detailed the foundational steps and strategies put in place to realize the ambitious goals of the endeavor. The technologies chosen, based on my research and evaluation, are well-suited to the challenges ahead. However, while the preparations have been thorough, the actual test lies in the execution phase. Adherence to the milestones, effective management of resources, and an agile response to unforeseen challenges will be pivotal in ensuring the project's success. The efficacy of the models, once implemented, will depend heavily on iterative refinement based on testing and feedback.

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# "Model Smart Building Operation Control System"

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## Abstract

Due to the rapid growth of technology, the Internet of Things (IoT) has been integrated into a variety of sectors, including the realm of smart building operation control systems. This research delves into the ideas and uses of IoT in the context of a smart building, where automation, data gathering, and analytics all work together to improve efficiency, sustainability, and user experience. This IoT concept intends to revolutionize existing building management methods by harnessing a network of sensors, actuators, and intelligent devices.

This research digs into a critical assessment of developing IoT technologies that support the concept, with a particular emphasis on detecting, measuring, storing, and presenting environmental data within a building. We evaluate the significance of acquired data by an in-depth examination of key data sources, substantiating its usefulness in optimizing energy usage, predictive maintenance, space utilization, and security enhancement. This data-driven approach's impact on building management practices is investigated, demonstrating its potential to transform operational paradigms.

The report's design part includes a thorough analysis of the IoT model's architecture, complete with extensive schematic diagrams and simulations utilizing tools such as TinkerCAD and Packet Tracer. It goes into detail about the deployment of sensors, actuators, connectivity options, and data visualization tools, explaining their roles in real-time monitoring, analysis, and automation. This design is supported by real implementation and testing scenarios that demonstrate the IoT model's effectiveness in getting its objectives.

## 1. Introduction

The Internet of Things (IoT) changed the landscape of industries worldwide, and building management is no different. The confluence of intelligent devices, sensors, and networking has given rise to the concept of smart buildings, which combine real-time data collecting, analysis, and automation to create more efficient, sustainable, and user-centric environments. This research digs into the fundamentals, applications, and impact of IoT in the context of a Smart Building Operation Control System, explaining how this paradigm shift is altering how buildings are controlled and run.

## 2. Overview of Smart Buildings and IoT

Smart buildings, also known as intelligent or connected buildings, use IoT to allow for seamless interaction between physical infrastructure and digital processes. This synergy provides unprecedented insights and control over numerous aspects of the building, ranging from energy usage and environmental conditions to security and tenant comfort. The IoT-powered smart building ecosystem is a network of sensors, actuators, controllers, and communication networks that work together to collect data, draw insights, and execute actions in real time.

There are numerous benefits to deploying an IoT-based Smart Building Operation Control System. Building managers can acquire precise insights into the building's performance and occupant comfort by employing a varied array of sensors ranging from climate control to occupancy monitoring. Real-time data collecting allows for data-driven decisions that optimize energy consumption, resulting in significant cost savings and reduced environmental impact. Predictive maintenance reduces downtime and increases the operational lifespan of important systems by enabling continuous monitoring and analysis of equipment conditions.

Furthermore, IoT technology improves security by enabling enhanced access management and providing real-time alerts in the event of unauthorized activity. Occupant safety is enhanced by responsive systems that adapt to changing environmental circumstances, such as automatic lighting and temperature modifications based on occupancy and time of day.

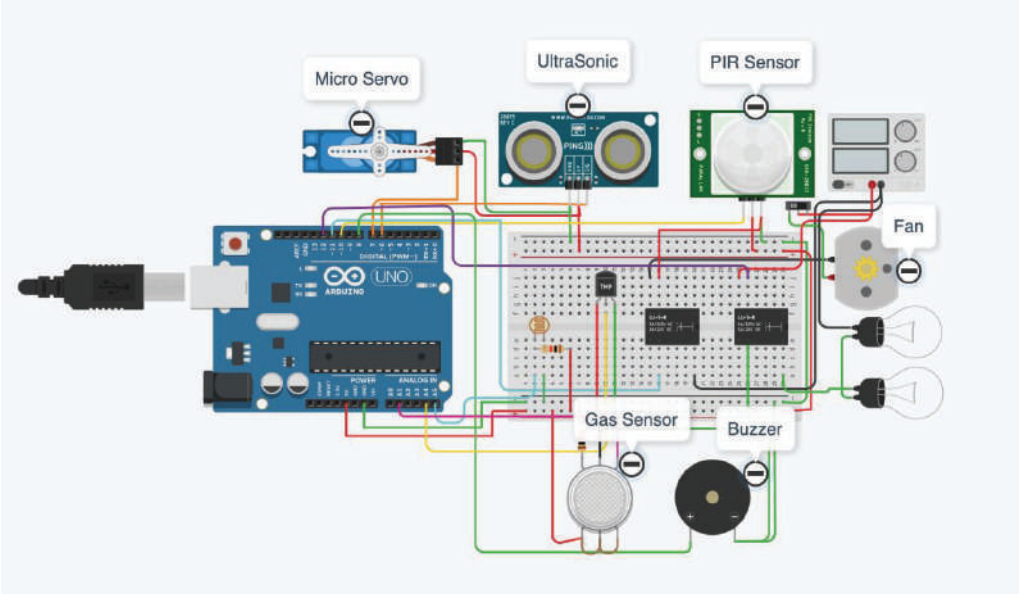
## 3. Overview Diagram

## 4. Objectives of the Design

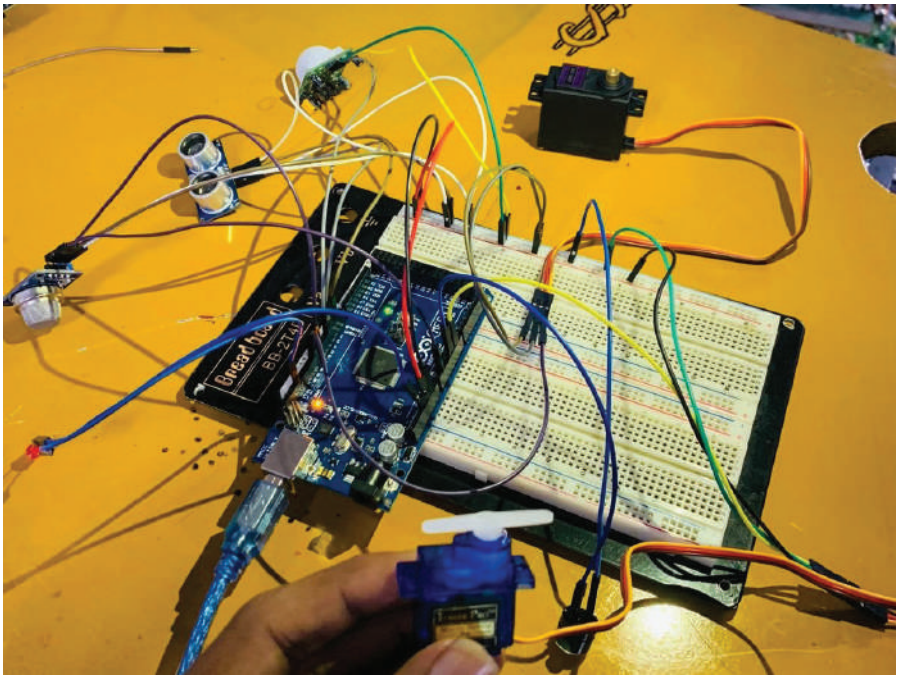
The purpose of the present study is to thoroughly investigate the delicate interplay between IoT technology and smart building management. It defines the fundamental principles that underpin the Internet of Things paradigm and critically assesses emerging technologies that enable its implementation in building automation. The research emphasizes the importance of sensory data in decision-making and dives into its relevance and impact on building performance optimization. The report thoroughly covers the process of creating an IoT-based Smart Building Operation Control System, including everything from sensor selection and connectivity options to data visualization and analysis tools. The installation and testing phases are meticulously documented, providing insights into the model's practical deployment and real-world effectiveness.

In search of holistic insights, the work also addresses the established system's strengths and limits, opening the path for potential future advancements. It also examines the ethical, legal, and social issues of incorporating IoT into building management, assuring a responsible and sustainable approach to technology adoption. As we continue our investigation into IoT-driven smart building management, the parts that follow will delve deeper into the underlying technology, design considerations, implementation methods, and potential future advances. The goal is to highlight IoT's transformative potential in redefining the landscape of building operations, guiding us towards more efficient, sustainable, and user-centric structures that reinvent how we interact with our built environments.

## 5. Schematic Diagram



## 6. Model Evaluation



## 5. Conclusion

I have investigated the fundamental principles of IoT and its implementation in smart buildings throughout this project. and investigated the roles of various sensors and actuators, reviewed communication protocols such as MQTT, and investigated how platforms such as Blynk and the Arduino IDE help to the realization of this novel system.

The system's strengths are obvious: it improves energy efficiency, forecasts maintenance needs, increases security, and provides tenants with remote control and real-time monitoring. However, there are certain hurdles, including as initial expenses, technical complexity, and dependability and security issues.

The IoT-based Smart Building Operation Control System is a game changer in intelligent building management. I've designed a system that not only optimizes resource utilization but also improves the quality of life for building inhabitants by using the possibilities of IoT. As technology advances, this system will remain at the forefront of producing sustainable, comfortable, and efficient spaces that meet the demands of inhabitants and the environment both now and in the future.

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# "Smart Door Lock System"

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## Abstract

The advent of the Internet of Things (IoT) has revolutionized the way we interact with everyday objects, including door locks. Smart door lock systems represent a significant advancement in home security and automation. This abstract provides a comprehensive overview of smart door lock systems, their functionality, benefits, challenges, and potential future developments.

Smart door lock systems are designed to enhance security, convenience, and accessibility. They employ a variety of technologies such as Bluetooth, Wi-Fi, RFID, and biometrics to enable remote control and monitoring through smartphones or other connected devices. This connectivity allows users to lock or unlock doors, grant temporary access, and receive real-time notifications, providing a heightened sense of security and convenience.

The benefits of smart door lock systems extend beyond mere convenience. They can improve home security by enabling users to monitor access and receive alerts in case of unauthorized entry. Additionally, these systems can integrate with other smart home devices, such as security cameras and voice assistants, to create a seamless and interconnected home ecosystem.

However, smart door lock systems also come with challenges, including concerns about cybersecurity and privacy. Vulnerabilities in the software or hardware could potentially compromise the security of a home, making it imperative for manufacturers and users to prioritize security measures and best practices.

As the technology evolves, smart door lock systems are likely to witness continued innovation. Future developments may include enhanced biometric recognition, artificial intelligence integration, and increased interoperability with other smart devices. These advancements are expected to further improve the overall user experience and security of smart door lock systems.

Smart door lock systems represent a transformative shift in home security and automation. They offer a range of benefits, including convenience and improved security, while also presenting challenges that need to be addressed. As the technology continues to evolve, the future holds promise for even more advanced and integrated smart door lock systems, making them an exciting area of innovation and development in the field of IoT and home automation.

## 1. Introduction

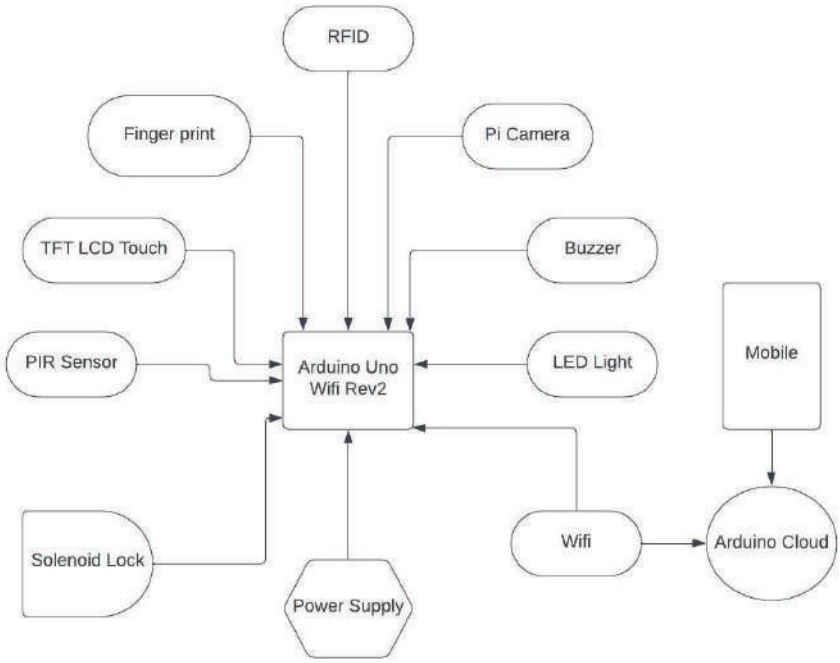
Every living thing wants to be safe, whether that safety is regarding his possessions or his own priceless life. In this project, we suggest a smart door lock system that relies on the Internet of Things to function to stop trespassing and unlawful access. Unauthorized access typically occurs in banks, financial institutions, government offices and organizations, and retail locations therefore, this smart door lock system is very useful.

## 2. Methodology

System Implementation

- Internet of Things (IoT)-based smart door lock system involves integrating the smart lock with the IoT ecosystem, enabling remote access, monitoring, and control through the internet.
- Define Objectives and Requirements: Clearly outline objectives for the IoT-based smart door lock system. Determine the specific features and functionalities want, such as remote access, security monitoring, or integration with other IoT devices.
- Choose the Right IoT Smart Door Lock: Select a smart door lock that is IoT-compatible and aligns with your objectives. Ensure it supports the necessary communication protocols, such as Wi-Fi.
- Purchase the Hardware: Acquire the smart door lock system, including the lock itself, power source, and any additional IoT devices or sensors planned to integrate with the system.
- Install the Smart Door Lock: Installation instructions for both the physical installation of the smart lock and the setup of IoT connectivity. Ensure a secure and accurate installation.
- Set Up IoT Connectivity: Connect the smart lock to the home Wi-Fi network or other relevant IoT network infrastructure. Ensure a stable and reliable connection.
- Configure User Access and Permissions: Use the Arduino platform to configure user access permissions. Assign authorized users unique access codes or digital keys. Determine administrative privileges for system management.
- Implement Security Measures: Ensure the IoT-based smart door lock system is secure by configuring strong passwords, enabling encryption, and keeping firmware up to date. Regularly monitor access logs.
- Set Up Remote Access: Configure remote access options through the app or IoT platform. Ensure that remote access is secure and protected with robust authentication methods.
- Test the System: Thoroughly test the IoT-based smart door lock system to ensure all features and integrations work as intended. Test remote access and monitoring to verify proper functionality.
- Monitor and Troubleshoot: Continuously monitor the system for any issues or anomalies. Perform routine maintenance, including power and software updates. troubleshooting steps for potential system malfunctions. Contact customer support or seek assistance from IoT experts if needed.

Block Diagram




Qualitative Approach

Choose appropriate qualitative research methods to collect data. Common methods for evaluating smart door lock systems include:

Interviews: Conduct one-on-one interviews with users, installers, or stakeholders to gather in-depth insights and opinions about the system.

Focus Groups: Organize focus group discussions with a small group of participants to facilitate open conversations and idea sharing.

Surveys: Develop open-ended survey questions that allow participants to provide detailed responses about their experiences with the smart lock.

Observations: Observe users interacting with the smart lock system in their natural environment to understand how it is used in practice.

Content Analysis: Analyze user reviews, feedback, or comments on online platforms and social media to gain insights into user experiences.

Quantitative Approach

Choose appropriate quantitative research methods and data collection techniques. Common methods for evaluating smart door lock systems include:

Surveys: Create structured questionnaires or online surveys with closed-ended questions that can be easily quantified. Ensure that the questions align with research objectives.

Observational Studies: Use objective metrics, such as the time taken to lock or unlock the door, to assess the system's efficiency.

Log Analysis: Collect and analyze system-generated logs and data, such as access history, to identify patterns and trends.

## 3. Legal and Ethical Issues

Data Privacy Smart door lock systems collect, and store data related to user access patterns, such as when doors are locked or unlocked. There may be concerns about how this data is used, stored, and shared, as well as whether it could be accessed by unauthorized parties. Cybersecurity Vulnerabilities in the software and hardware of smart door lock systems can be exploited by hackers. Remote locking the ability for homeowners to remotely lock and unlock doors raises questions about misuse or abuse of this feature, such as locking someone out of the home without their consent. Third-party access smart lock systems may allow integration with third-party services, such as delivery companies or home-sharing platforms. Issues related to who has access to the locks and for what purposes can raise ethical and legal questions.

## 4. Conclusions

The project of a smart door lock system offers a range of benefits that enhance both convenience and security for homeowners and businesses. As technology continues to advance, these systems are becoming increasingly reliable, user-friendly, and accessible. With features such as remote access, keyless entry, and real-time monitoring, this smart door lock system provides peace of mind, convenience, and flexibility like never before and cybersecurity. Therefore, as we embrace the convenience of smart door lock systems, we must also remain vigilant in maintaining their security to ensure they continue to serve as reliable guardians of our homes and properties. As technology continues to evolve, this smart door lock system is poised to play an even more significant role in our lives.

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# Software Define Network Services and Security

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## Abstract

The conventional structure of networked devices is showing signs of becoming adequate for the exigencies of new technological developments like puff figuring, online of belongings, fetch your individual tech, and the development of online amenities due to the lightning- quick growth of digital systems. Significant utilizing, great store obtainability, active roadways couture, tackle mechanization toughness, a full scheme information, and other needs must be met for these advancements and services, but network design has proven to be exceedingly difficult in the realms of flexible system execution, dynamic system settings, agile machine estimation, and able to adapt framework submitting.

Software Defined Networks (SDN) have been anticipated as a new philosophy handing out flexibility, while traffic surveillance, and adjustable the design due to the basic design of ancient systems for the past fifteen years and the dynamic nature of the latest applications. The software-defined networking provides obvious centralization and agility that allows it to respond to changing demands, but it is exposes it to new criminal acts, threat possibilities, and potential dangers to safety that might undercut it. However, SDN also has several security danger signs that have happen as a result of the emergence of SDN.

As a result, the most recent SDN security flaws have been analyzed soon after a thorough research. The Systematic behavior Literature Review (SLR) contains 69 renowned journals that were released between 2014 and 2020. Investigation of SDN threats, their underlying causes, go for aircraft, the cost of suggested fixes, and security problems are the main objectives of SLR. This SLR offers a multifaceted strategy that considers both technical improvements and risks, with each layer which describes different reliability assaults, their real-world causes, and possible remediation measures. A few undecided problems and difficulties have been provided to aid in determining the next course of action regarding the security and privacy of SDN. Future SDN investigating security will have further instruction to explore thanks to this finding thing.

## 1. Introduction

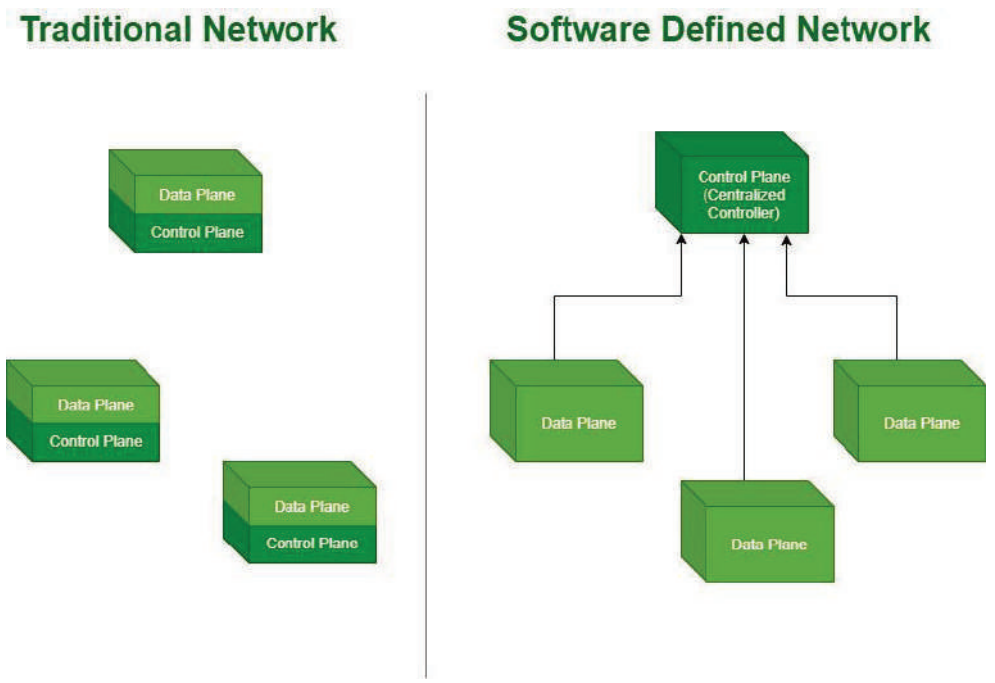
A system scheme concept entitled Software-Defined Networking (SDN) permits networks to be automatically and centralized measured, or "encoded," consuming software applications. Irrespective admiration to the fundamental networked devices, this allows machinists to control the whole web repeatedly and extensively.

Plentiful rival masses have surrounded productions, movers, and facility breadwinners. Customary corporate models will be wrecked by the immense extension of combination, the detonation of computing in the cloud, the effects of rising mobile usage, and ongoing business pressures to cut costs as revenues continue unchanged.

When the control layer takes care of many devices, there needs to be a tangible distinction with regard to the network control plane with the plane that forwards data.

An acquiring paradigm called Software-Defined Networking, or SDN, is shifting, manageable, accessible and flexible which renders it seamless for the apps-bandwidth, variable nature of contemporary workloads. This design allows network administration to be programmable directly and the transfer activity to be detached from the other ones.

Program and Structure comforts require a restitution of the crucial erection infrastructure. The OpenFlow® protocol is a key fundamental component for SDN resolutions. Verify out the freely available source microbook "Software-Defined Networks: A Systems Methodology" for an extensive overview of SDN-based networking and use cases.



Using the SDN Architecture:

1. OPERATING SYSTEM STRAIGHT:
   Network control can be manually configured because it operates individually when transmitted functions.

2. AGILE:
   Superintendents' canister energetically variation network-wide circulation flow to suit shifting needs by separating control from accelerating.

3. IN CENTRAL CONTROLLING:
   Software-based SDN switches that keep a worldwide perspective regarding the internet, which seems near see clients and rule algorithms by way of only one rational toggle adjustment, are somewhere the network's astuteness is (logically) concentrated.

4. CONTAINED PROGRAMMATICALLY:
   Overwhelming forceful, automatic SDN programs that are self-governing of confidential software, SDN qualifies managers of networks towards organize, oversee, protect, and maximize complex components actual speedily.

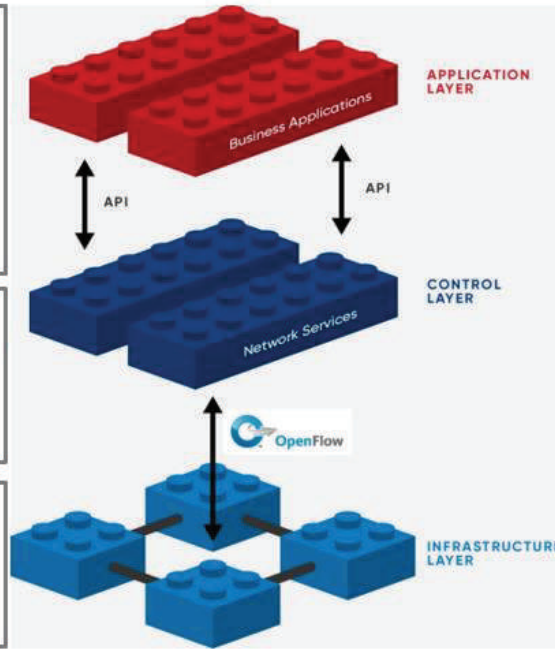
5. OPERATING SYSTEM-NEUTRAL AND DESIGNED ON OPEN REQUIREMENTS:
   SDN kinds of set-up policy and operation meeker when it is realized consuming uncluttered ethics since SDN controls instead of some, vendor-specific procedures, and etiquettes suggestion advice.

**Overview**

**Application layer**
The typical internet applications or features that corporations use are situated at their application layer. This might involve firewalls, and distribution of load, or systems to detect intrusions. A operating system-defined connection inserts an application that utilizes a control system for managing the information plane conduct where ordinary networks would utilize specially designed supplies, such as a network firewall or load analyzer.

**Control layer**
The software-defined development tools's primary SDN system, or control layer, is captured by this layer. This system, generally gets stored on a server, handles operating system-wide protocols and traffic patterns.

**Insfrastructure layer**
Actually functioning switches for networks make up the physical infrastructure layer. The interconnected system arrivals gets routed to its places to see by these types of switches.




(opennetworking.org)

APIs Northbound and southbound APIs are implemented by each of these layers for communicating among the others. Utilizing its northbound interface is, the instrument distributes with opportunities. Although there are multiple standards, the control unit and switches express yourself by means of southbound protocols like OpenFlow.

Functional racial division set-up virtualization, and mechanization through scripting are only a insufficient of the methodologies that SDN development tools. The primary objective of the concept of SDN was centered the division of the web resistor plane and data plane. The data skies transport the signals from a certain spot to another while a command plane deems the way they ought to flow through the internet.

An arrive packet finds its way to the computer system switch in that is typical SDN settings. The switch's exclusivity computer software faces rules deciding for it where send the packet. The decision to move obtains each of these apps-handling rules from the integrated controller.

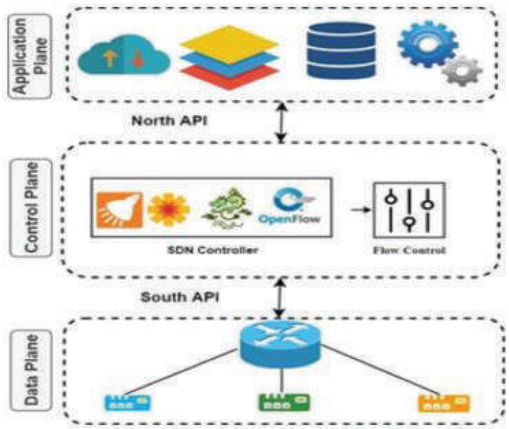
## 2. Methodology

### Security Assessment Techniques Methodology

The evaluation handle that is put forward in this part seeks that will help enterprises in deciding on the security of SDN technology. In order to assess whether or not there is a presence of the pitched assurances, this strategy has been centered on a top-down strategy to the SDN designing buildings. The evaluation is based on a set among pre-selected steers considering from the NIST 800-53 submission. Use recommendations. approaches as follows:

### System Implementation

Step 1: Assessing the devices being controlled. The user should assess whether influences are present and effective in a particular SDN installation. The user gets an list of the current, non-existent, and restitution procedures the address provided current flaws in SDNs as a result of this phase.




(Ahmed et al.)

Step 2: Scoring and SDN analysis come next. During this phase, a grade will be assigned to each of the resulting controls. The importance of each SDN functionality to the business should be considered while calculating the score. This rating must be established based on the company's safety standards, guidelines, and regulations. A comparison of the data acquired in the current phase will provide a quantitative evaluation of the safety elements of the ranking SDN controller in relation to a particular business.

### Evaluation of the Project Test and Assessment

In this provision, we put what has been advocated in the current inquiry to the test throughout a comparison and a test of viability. The commercial SDN-based controller Ryu is utilized in the potential benefits test.

When as opposed to competing advertisement controlling devices like ONOS and operating system Ryu is far more advanced in areas like functionality security, in addition to stability, which is the explanation why we chose it. However, Ryu developed the system in Python, so its structure and code nature make it easier to quantify thoroughly the positive effects of the approach, hence decreasing assessment complexity. In the comparing test, we first contrast various Ryu iterations in order to assess how secure they are.

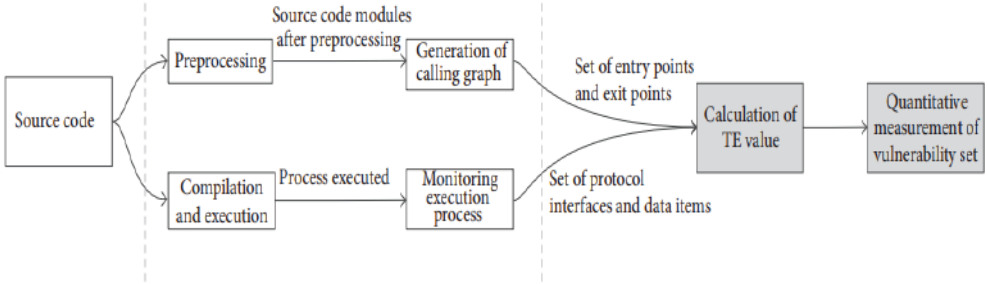



FIGURE 5: Flow graph of quantitative measurement for vulnerability set.

## 3. Conclusions

Using the System Security Evaluation Methodology provided in this paper, network security experts can rank different SDNs in terms of safety. Enterprises can benefit from the analysis and conclusions of this article by doing a thorough SDN security investigation and selecting the appropriate SDN hardware considering the results. To plug security gaps discovered in the ideal SDN environment, the proposed metrics provided here can be used as guides.

In contrast to previous SDN assessment of security tools, which can only be used to test only a particular number of SDN controllers which under a predefined the globe that may differ from your company defined environment, this research offers a thorough method for the organizations to assess security in any SDN the infrastructure. The efficacy and adaptability of the proposed approach have been demonstrated by what were the experiment's results. The idea of automating all control rating processes using, for an example SCAP rules to improve the proposed method.

We encountered that proactive or reactive techniques may address different level of artificial intelligence (self-* capabilities) and may be combined coupled to produce instinctive protection measures. Nevertheless, it's critical for them to assess the complexity of their use, which affects install costs. We have presented ranking of security solutions designed to demonstrate the point of automation made possible about each tactic and the difficulty of putting one of them into operation.

We also studied about the features that were essential for a thorough evaluation of the safeguarding solution settings, including the scalability ingredient. We may select whether to

use a firewall or another type of security specifically for specific production networks after identifying its benefits, drawbacks, in conjunction expenses.

We believe that the research and development of original and instinctive security solutions for networks of the next decade is the true aim of SDN technology, when we hope that conversations and the search will help readers gain an in-depth awareness of how the SDN precedent is driving this shift in technology.

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# The Environmental Impact of Digital Transformation on Ecosystem Disruption and Biodiversity Conservation

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## .Abstract

Throughout the past few decades, many researchers and practitioners have paid a lot of attention to digital change. Digital transformation refers to the big changes that are happening in every part of society, organizations, and businesses because of the use of digital technologies like artificial intelligence (AI), big data analytics, the Internet of Things (IoT), blockchain, and other technologies. The digital age has brought a new time of connection, ease, and new ideas. From the rise of smartphones to the exponential growth of data-driven technologies, the digital sector has changed how we live, work, and talk in basic ways. But this amazing growth has not been without problems. As we speed toward a time when data creation and storage are expected to hit 175 Zettabytes by 2025, which is a six-fold increase from 2018, more and more people are worried about how this digital revolution will affect the environment.

This growing digital world needs a lot of gear and energy, which makes the Information and Communication Technology (ICT) sector's impact on the environment worse. As more people around the world realize how important it is to stop climate change and protect the environment, it is more important than ever to look at how our digital shift affects the environment. This study tries to look into the deep effects that digitalization has on ecosystem disruption and biodiversity conservation. It also looks into the complicated relationship between technology progress and ecological health. Digital transformation, which is the use of technologies that affect all parts of human life, gives people hope that the world will get better. Concerns have been made in the meantime about the effects of digitalization on the environment. The link between digital transformation and environmental sustainability is complicated, and scientists have had different ideas about whether digital transformation helps or hurts environmental sustainability.

## 1. Introduction

### The digital explosion and the damage it do to the environment

The rise of digital tools has been nothing short of a revolution. With the rise of high-speed internet, cloud computing, and the Internet of Things (IoT), our world is more linked and data-driven than ever before. This digital explosion has changed businesses, streamlined processes, and opened up chances for innovation that have never been seen before. But the excitement about digitalization has made people forget how bad it is for the earth.

In just a few decades, almost every part of our lives has changed from traditional to digital. Smart homes, self-driving cars, and a growing number of online services are now routine. But

this change does not come for free. The constant need for data has led to the development of huge data centre's that use a lot of power. With their rows of computers and cooling systems, these data centre's use a huge amount of energy, which leads to a rise in greenhouse gas emissions.

Also, making and throwing away electronic devices, which are a big part of the digital age, adds to e-waste and makes the world even dirtier. Mining for rare earth minerals, which are used to make computer parts, leaves scars on the surface of the earth and upsets local ecosystems. This double effect on the environment—using energy and making e-waste—shows how important it is to look at the effects of our digital dependence right now.

**The Climate Crisis Getting Worse**

The global climate disaster, which is caused by things like rising temperatures, extreme weather, and the loss of biodiversity, is one of the biggest problems that people face. It is a problem with many different parts and effects that go far beyond melting ice caps and more hurricanes. It includes the destruction of ecosystems, the loss of species, and the upsetting of delicate ecological balances.

As the digital industry keeps growing, it makes the climate problem worse. Because data centres and the rest of the digital infrastructure use a lot of energy, they leave a big carbon footprint. It takes a lot of energy to keep, process, and send data, and most of that energy comes from fossil fuels. This reliance on energy sources that do not replenish themselves makes carbon pollution worse, which speeds up global warming even more.

Also, the growth of the digital sector puts a lot of stress on environments and resources. When building and running data centres, people often cut down trees and destroy habitats. When minerals that are needed for electronics are taken out of the ground, it hurts fragile ecosystems and changes the native homes of many species. This worsening environmental disaster shows how important it is to investigate how the digital sector affects ecosystems and biodiversity as soon as possible.

**The Digital Paradox: It is good, but it is not sustainable.**

In terms of using less energy and having more computing power, the digital sector has made a lot of progress. Moore's Law has been true for decades. It says that the number of transistors on a computer double about every two years. Because of this exponential rise in computing power, algorithms and data processing have become more efficient while using less energy. But there is a strange twist to this efficiency.

Even though digital growth is becoming more efficient, its sheer size makes it unstable. The rise of data creation and storage, which is driven by trends like big data analytics and the Internet of Things (IoT), is always faster than the gains in efficiency. The more data we make and use, the more energy we need to make it happen. It is like trying to run slowly on a treadmill that speeds up. So, even though the digital sector has made a lot of progress in decoupling computing power from energy use, the total effect on the environment keeps getting worse because the digital ecosystem keeps growing. So, it is important to find a balance between technological progress and protecting the earth.

**The Need for a more environmentally friendly**

In a time when the environment is a big part of the global agenda, it is up to us to realize that we are all responsible for tackling problems like climate change and the damage of ecosystems. As people who work in the digital field and have a stake in it, we have a special responsibility. Digital technologies have helped people make progress, but now they need to be used to reduce the damage they do to the world.

To be sustainable in the digital field, you need to look at things from many different angles. This includes using green energy sources to power data centers, making hardware and software that uses less energy, and making a promise to reduce e-waste by recycling and making products that are better for the environment. At the same time, we need to look into new ways to limit the damage that digital growth does to the environment, such as edge computing and green data centres.

Also, as the world comes together behind the Sustainable Development Goals of the United Nations, it is important that the growth of the digital industry be in line with these global goals. This means not only lowering the negative effects on the environment, but also using digital tools to move forward with sustainability goals. From smart grids that make the best use of energy to precision agriculture that saves resources, the digital industry can be a force for good in dealing with the global climate emergency.

In response to these problems, the world has been putting more and more stress on addressing climate change, protecting ecosystems, and keeping biodiversity safe. The Sustainable Development Goals (SDGs) of the United Nations lay out a complete plan for reaching these goals, considering how environmental, social, and economic sustainability are all linked.

Because the digital sector is such an important part of modern life, its effects on the environment cannot be ignored in the pursuit of these global goals. To stop the worsening climate disaster, the disruption of ecosystems, and the loss of biodiversity, it is important to take a close look at the link between digital transformation and environmental sustainability.

This study aims to close this important gap by looking into the complex links between digitalization and its effects on the environment. By taking a full look at how the digital sector affects ecosystems and biodiversity, we can better understand the challenges and possibilities that come with a world that is changing so quickly. Also, the goal of this study is to find ways to balance the continued growth of the digital sector with the need to protect the environment.

## 2. Literature review

In recent years, there has been more and more talk about how digital change affects the environment, especially when it comes to ecosystem disruption and protecting biodiversity. This review of the literature looks at the most important studies and points of view in this field, shedding light on the complicated dynamics, challenges, and possible solutions linked to the effects of the digital age on the environment.

**Digitalization and the amount of energy used**

Energy use has gone up a lot because the digital industry is growing so quickly. Koomey's landmark study from 2017 showed how data centers are using more and more energy. He

estimated that they used about 1% of the world's power. The study showed how important it is for data centers to switch to green energy sources to reduce their carbon footprint.

**E-waste and the use-up of resources**
Because people want the newest technologies, they throw away their electronics quickly. This has created a big problem with e-waste. Geng et al. (2019) point out that electronic waste is not only bad for the earth but also a missed chance to save resources. To lessen the damage that electronic trash does to the environment, it must be recycled and thrown away in a responsible way.

Also, taking rare earth minerals out of the ground to make electronic parts is linked to habitat damage and pollution. Heinrich et al. (2018) stress how important it is to use sustainable mining methods and source minerals in a responsible way to reduce the damage that mineral extraction does to the environment.

**Ecosystem Damage and Loss of Habitat**
The growth of the digital sector, especially the building and running of data centers, often causes environment loss and damage. BenDor et al. (2015) looked at the effects of data center sprawl on land use. They focused on how natural areas were turned into infrastructure. They argue for better planning of how land is used and for taking ecological factors into account when choosing a place.

Laestadius et al. (2016) also talk about the ecosystem services that natural habitats provide and what might happen if they are changed because of the growth of digital infrastructure. Ecosystem services, like pollination and water cleaning, are important to human well-being. This shows how important it is to find a balance between digital growth and environmental protection.

**Conservation of biodiversity and digital technologies**
The digital sector also has new tools that can help protect wildlife. Maffey et al. (2019) look into how digital technologies like remote sensing and data analytics can be used to keep an eye on wildlife areas and protect them. These technologies make conservation efforts more exact and effective, which could reduce some of the bad effects of digitalization.

**Green technologies and sustainable ways of doing things**
Many researchers have looked into sustainable practices and green tools to help solve the environmental problems caused by the digital transformation. Koomey et al. (2017) say that making data centers more energy efficient can make them much less harmful to the environment. They stress the value of new technologies like advanced cooling systems and server designs that work better.

Widen and Crettaz (2019) look into edge computing as a way to make data centers greener. Edge computing is a decentralized method that lowers the need for centralized data centers. This method could cut down on the amount of energy used and lower the amount of damage done to the ecosystem by large data centers.

**Frameworks for Policies and Rules**
We can not say enough about how important policies and rules are for reducing the negative effects of digitalization on the earth. Lenzen et al. (2020) talk about how the digital sector needs a policy strategy that looks at both the supply and demand sides. They suggest things

like putting a price on carbon and using eco-labels to encourage people to act in a healthy way.

**Innovation and long-term survival:**
A common theme in the writings is the need to find a balance between digital innovation and environmental sustainability. Garrido et al. (2021) say that responsible innovation in the digital sector needs to think about how new technologies affect the environment and society as a whole. They come up with a framework for figuring out how long digital innovations will last, stressing the importance of social and environmental factors.

**Changes to ecosystems and the growth of digital infrastructure**
When digital infrastructure grows, like when data centers and communications networks are built, ecosystems are often broken up and thrown off balance. A study by Soga et al. (2017) shows how digitalization can cause urbanization, which can separate natural habitats, reduce genetic diversity, and make species more vulnerable to changes in the environment. This shows how important it is to think about environmental issues when planning cities and building infrastructure.

**Technologies for keeping track of biodiversity and saving it**
Digital technologies offer tools that could help track and protect biodiversity. Ahumada et al. (2018) talk about how camera traps and sensor networks can be used to collect information about wildlife groups and how they act. Researchers can get useful information from these tools without disturbing natural habitats too much.

**Blockchain and Making Supply Chains More Sustainable**
People are paying attention to blockchain technology because it could make supply lines more open and sustainable. Ivanov et al. (2019) look at how blockchain can be used to find out where products come from, especially in businesses that have an effect on biodiversity, like timber and seafood. This can help stop illegal logging and overfishing, which will protect environments and species.

**Digital Initiatives to Get People Involved in Conservation**
Digital tools and social media are being used more and more to get people involved in conservation work. Fieseler et al. (2017) look into how social media can help encourage people to act in ways that are good for the environment and raise knowledge about the need to protect biodiversity. They show how social media campaigns can bring people together to help conservation issues.

**Assessing the effects on the environment in digital planning**
Environmental impact studies (EIAs) are becoming more important as digital infrastructure continues to grow. Maitre-Ekern et al. (2018) say that it is important to do full EIAs when planning and building data centers, taking into account things like energy saving, land use, and preserving habitat. They say that putting ecological factors into EIA methods can help lessen the damage to the environment.

**Electronics and the Circular Economy**
The idea of a circular economy is becoming more popular as a way to deal with the problem of electronic trash. Geissdoerfer et al. (2017) talk about the possibilities of circular business models in the electronics industry. They focus on practices like reusing and recycling products and making devices that are modular and last longer. These methods make electronics less harmful to the earth and help conserve resources.

Also, groups like the "Right to Repair" movement fight for the right of consumers to fix and keep their own electronics. Potts et al. (2020) look at what these policies mean for lowering e-waste and making the electronics industry more sustainable.

**Using digital technologies to slow down climate change**
Digitalization poses problems for the environment, but it also has ways to help stop climate change. Mahdavinejad et al. (2017) talk about how smart grids and other energy-efficient technologies could help reduce carbon emissions from making and using power. These tools improve the way energy is distributed and used, which helps meet climate goals.

Digital tools also make it easier to keep track of carbon emissions and put carbon offset programs into place. Xu et al. (2020) look at how blockchain technology can be used to make carbon offset markets that are honest and open. This would allow organizations to invest in projects that store carbon and protect wildlife.

## 3. Methodology

In this study, a quantitative analysis technique is used to investigate the environmental implications of digital transformation in relation to the disruption of ecosystems and the conservation of biodiversity. According to Creswell & Creswell (2017), quantitative analysis enables the methodical acquisition and evaluation of numerical data, providing empirical support to address research questions and evaluate hypotheses. This is one of the benefits that quantitative analysis offers. In the next part, the research design, data collection processes, and data analysis methods that were used in this study are broken down in detail.

Methods for the Collection of Data
Data from Secondary Sources: A Review of the Literature
Research Based on Quantitative Methods
Information from a Case Study

## 4. Conclusion

As we draw the curtains on this report, we do so with the awareness that our research represents a significant stride towards comprehending the environmental impact of digital transformation. Nevertheless, we acknowledge that the journey towards a comprehensive understanding is an ongoing one, and there exist fertile grounds for future expansions and deeper explorations in this domain.

Future research endeavors could derive substantial benefit from the implementation of longitudinal studies. Such studies would extend their gaze beyond the confines of the present moment, delving into the evolving landscape of digital transformation's environmental impact over extended periods. By tracking sustainability efforts and environmental outcomes across time, researchers would be better equipped to discern trends, patterns, and shifts within the digital sector. These longitudinal insights would illuminate whether the strides made in energy efficiency, e-waste management, habitat preservation, and biodiversity conservation are sustained or subject to fluctuation. In essence, longitudinal studies would render the sector's

journey towards environmental sustainability a dynamic narrative, one replete with valuable lessons and insights that can inform future policy, industry practices, and innovation.

**Policy and Industry Collaboration**
Collaboration between policy-makers and industry stakeholders represents a linchpin in the pursuit of environmental sustainability within the digital sector. Future research can delve into the effectiveness of policies and collaborative initiatives aimed at fostering sustainability. One avenue of exploration lies in evaluating the impact of initiatives such as green data centers, which prioritize energy efficiency and renewable energy adoption. Through systematic analysis, researchers can assess the degree to which these initiatives contribute to reducing the sector's environmental footprint. Furthermore, research can scrutinize the dynamics of collaboration between governments, industry leaders, and environmental organizations in shaping sustainability agendas. By dissecting successful collaborations and identifying challenges, future research can offer insights into how policy and industry can synergize their efforts to achieve lasting environmental impact.

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# "Cloud Box: High Availability Cloud Monitoring and Management with OpenStack"

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## Abstract

Cloud Box" initiative embodies a visionary effort dedicated to fortifying the global well-being through the application of advanced technologies in cloud monitoring and management. This project is underpinned by meticulous research practices, drawing insights from the realm of cloud computing to forge innovative solutions in OpenStack-based cloud environments.
The foundational phase involves an in-depth exploration of existing literature, unearthing established solutions and best practices in cloud computing. This knowledge forms the cornerstone upon which the project's objectives are established.

Central to the initiative is a comprehensive data collection strategy encompassing active and passive techniques to glean insights into system performance and resource utilization. The robust data collection process promises a holistic perspective on the cloud environment.
The project employs a rigorous testing and feedback framework to ensure resilience under diverse conditions, gathering critical insights and assessments from supervisors and peers.
Moreover, the data is meticulously analyzed for patterns and anomalies, paving the way for targeted improvements aimed at optimizing cloud performance and bolstering high availability.
The project emphasizes proactive stakeholder engagement, ensuring their concerns are addressed, thus preventing potential issues from escalating.

In summary, the "Cloud Box" project epitomizes a holistic, data-driven approach dedicated to fortifying cloud security and performance, promising resilient and secure cloud infrastructures to enhance global well-being.

## 1. Introduction

In today's digital era, CloudBox represents an open-source hardware cloud innovation that redefines cloud computing. It addresses the critical needs of businesses and organizations amid digital transformation. CloudBox offers a fully managed, flexible cloud service emphasizing data protection, on-premises processing, and ultra-low latency. It seamlessly integrates cloud computing, storage, and networking into existing data canters, enabling tailored cloud experiences. This initiative recognizes data's pivotal role in innovation and decision-making, prioritizing data security and control. CloudBox is poised to revolutionize cloud computing, empowering organizations to harness the cloud's potential in a digital landscape driven by data, creativity, and informed choices.

## 2. Research Methodology

1.Gathering Literature Sources/Documentation:

- Conduct a thorough review of existing literature, industry reports, and documentation related to your project's focus. Utilize academic databases, industry-specific sources, and online repositories for valuable insights.

2.Google Form Surveys:

- Create structured Google Forms tailored to the specific data you need from companies. Ensure questions are clear, concise, and aligned with your research objectives.
- Distribute the Google Forms to targeted companies and organizations that are relevant to your project.
- Request quantitative data related to their experiences, needs, or preferences in the context of your project. For example, if your project is related to cloud computing, you might inquire about their current IT infrastructure, cloud adoption, security concerns, or cost considerations.

3.Data Analysis:

- Collect and compile the quantitative data obtained from the Google Forms.
- Use statistical analysis tools and techniques to process and analyze the data, extracting meaningful patterns and insights.
- Generate visual representations (charts, graphs) to present key findings.

4. Benchmarking:

- Compare the quantitative data from different companies to identify trends, common challenges, or opportunities.
- Benchmark the gathered data against industry standards or best practices.

5. Data Validation:

- Ensure the accuracy and reliability of the collected data by verifying responses and cross-referencing with other internet sources.

## 3. Problem Statement

Organizations across industries face a significant problem in today's digital landscape: the requirement for a cloud architecture that combines the benefits of public cloud services with the control and security of on-premises solutions. Existing cloud products frequently fall short of meeting this dual requirement, leaving firms scrambling for a holistic solution that provides:

- Data Security: The paramount concern in the digital age is safeguarding sensitive data. Organizations, especially those in regulated industries, require cloud infrastructure that guarantees robust data security through encryption, authentication, and access control

mechanisms. Many public clouds can't provide the level of control necessary for compliance.

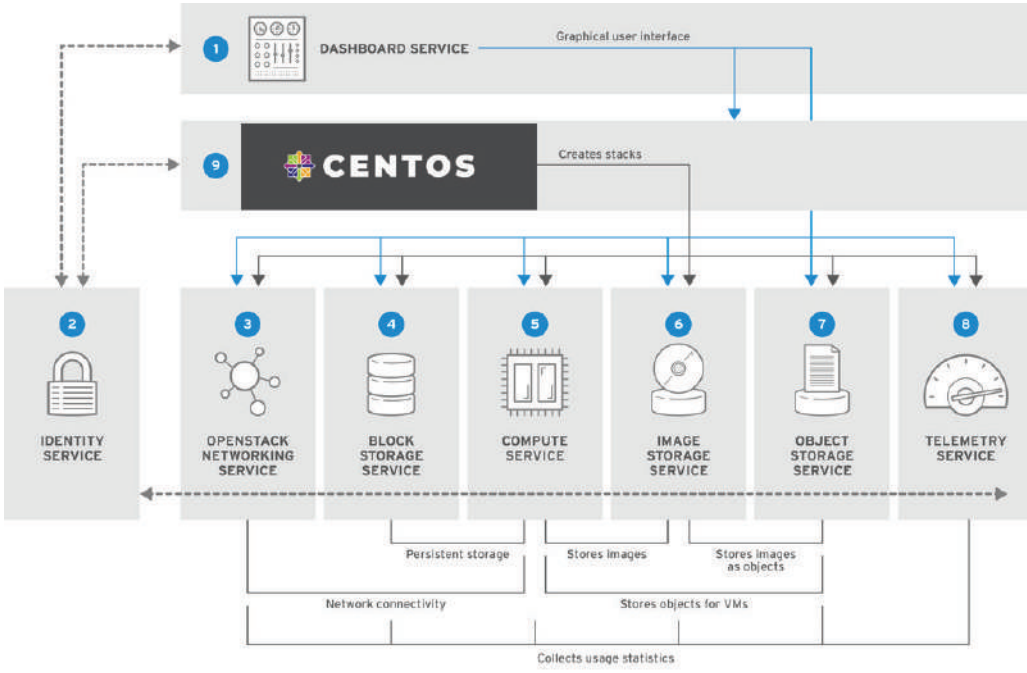
- On-Premises Data Processing: Some data processing tasks demand low-latency, real-time analytics, and absolute control over the processing environment. Existing cloud solutions may introduce latency and limit the flexibility required for these tasks.

- Full Cloud Integration: The seamless integration of cloud computing, storage, and networking into existing data centers is a challenge that organizations face. Customizing and deploying such solutions often prove complex and costly.

- Ease of Deployment: The complexity and resource requirements of setting up a private cloud can be daunting, causing delays and budget overruns.

- Open Source Flexibility: Proprietary solutions can limit customization and vendor lock-in. There's a growing demand for open-source solutions that are adaptable, extensible, and community-supported

## 4. Architecture Diagram



### 5. Results and Discussion

The research identified and addressed key challenges encountered by organizations in their pursuit of a comprehensive cloud architecture that amalgamates the advantages of public cloud services with the security and control found in on-premises solutions. Through a rigorous analysis of existing cloud products and the specific requirements articulated by diverse industries, a significant gap between available cloud solutions and essential organizational needs was highlighted. Key findings indicated that data security, on-premises data processing, seamless cloud integration, deployment simplicity, and open-source flexibility were critical areas where current cloud offerings exhibited limitations.

**Discussion:**

The identified challenges underscored the critical demands of modern organizations for a versatile cloud architecture. The insufficiencies observed in existing solutions were the primary drivers for the development and implementation of CloudBox—a comprehensive cloud solution that amalgamates the robustness of OpenStack, tools for migration, cloud monitoring, and security features. Notably, OpenStack formed the foundational structure, offering crucial services for compute, storage, and networking. The research-led approach for addressing data security leveraged AWS Identity and Access Management (IAM) for stringent access control, encryption, and threat detection. Additionally, CloudBox's migration tools, such as AWS Migration Hub, facilitated a seamless transition to the cloud environment.

Moreover, the integration of cloud monitoring tools like Amazon CloudWatch ensured real-time visibility into performance and resource health, enabling proactive optimization. The study recognized the critical importance of open-source flexibility and the need to mitigate vendor lock-in, thereby emphasizing CloudBox's adaptability and extensibility. The findings and subsequent deployment of CloudBox address the complex needs of organizations, offering a promising solution that amalgamates the virtues of public cloud services with the security and control essential for diverse industry landscapes. The research's outcomes exemplify a significant step towards meeting the pressing demand for comprehensive and versatile cloud architecture.

## 5. Conclusion

The Cloud Box project stands as a pioneering initiative in the pursuit of bolstering cloud security and high availability monitoring within OpenStack-based cloud environments, aligning with the theme of "Emerging Technology for Global Well-being" set forth by ICMR 2023. This project is underpinned by a profound commitment to leveraging data insights, comprehensive analysis, and stakeholder engagement to fortify cloud performance and security. Through rigorous data gathering, meticulous analysis, and robust testing, our endeavor aims to redefine cloud computing practices. The systematic evaluation of system performance and resource utilization is geared toward cultivating an optimized, high-availability cloud environment.

A core tenet of our approach is the proactive inclusion of stakeholders, ensuring that their insights significantly influence the project's direction. By preemptively identifying and

addressing concerns, we foster a cooperative environment, mitigating potential issues before they escalate and embodying a sense of shared responsibility.

The Cloud Box project embodies an enlightened pathway toward a more secure, efficient, and high-performing cloud ecosystem. By building upon established best practices, harnessing data-driven insights, and engaging stakeholders actively, we aim to set a new standard for cloud security and management. Our unwavering dedication to these principles not only propels us towards achieving project objectives but positions us as pioneers in revolutionizing cloud computing practices. This initiative marks a crucial stride forward in the dynamic landscape of cloud technology and security, emphasizing the value of comprehensive monitoring, meticulous evaluation, and a commitment to continuous improvement for the betterment of global well-being.

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## 8th INTERNATIONAL CONFERENCE ON MULTIDISCIPLINARY RESEARCH 2023

Session 03

## Legal Studies

# Adequacy of International Conventions to safeguard Children in Armed Conflicts: A critical analysis of International Humanitarian Law (IHL) and International Human Rights law (IHRL)

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**Abstract**

As children are subjected to vulnerability in armed conflicts they have been given legal protection under many International Instruments basically under International Human Rights laws (IHRL) and International Humanitarian Laws (IHL). Nevertheless, it is evidenced that there is no sufficient International legislations which safeguard the children in armed conflicts; due to non-availability of the International legislation the situation of the innocent children in armed conflicts remains critically worrying. Many international legal instruments have made special provisions for the protection of the children who are in armed conflicts but there are many incidents that have been reported and are being reported that the children in armed conflicts are used as human shields and forced into being combatants. The aim of this study is to critically analyze whether the available international laws specially IHL and IHRL are sufficient or adequate in seeking safeguard for children who are in armed conflicts. Qualitative method was used to analyze the data based on a normative argumentation approach in reference to articles of various scholars which had been published in Internet and also primary data were collected from leading International treaties, conventions, covenants and Guild lings, etc. This study analyzed only the International laws relating to IHL and IHRL as those instruments are the most significant legal documents for this of study. Based on the analysis this study concludes that there are some provisions for the protection of children in armed conflicts in International Humanitarian Law and International Human Rights laws are but that IHL and IHRL are not adhered to, by some state parties during the armed conflicts due to the fact that those conventions seems lack of binding power. Therefore, IHL and IHRL conventions do not yield positive or desired result for protecting children in armed conflicts.

**Key words** : Human Rights, International Humanitarian Law, International Human Rights Law, Child protection in Armed Conflicts ,Rights of Children.

## 1. Introduction

According to the Article 1 of the United Nations Convention on the Right of the Child (UNCRC) “a child means every human being below the age of 18 years unless under the law applicable to the child, majority is attained earlier.” but still different age limits are being used by many countries.

Human rights are closely linked with International Humanitarian Law for example Humanitarian law contains many human rights concepts such as Protocol 11 Article 4(2) and Protocol 1, Article 75 and Common Article 3 of the Geneva Conventions. Convention on the Rights of child being the major human right instrument has no sufficient or an individual does not cease to have basic rights once an armed conflict begins. Both International humanitarian Laws (IHL) and International Human Rights law (IHRL) provide protection for civilians, which includes children who are in armed conflicts but many of them were children (UNISEF 2015) According to UN reports last 10 years two million children reported to have been killed in armed conflicts and other fighting(s) and even more have been injured and permanently and partially disabled (UN Doc: A/51/306) this proves that IHRL and IHL have been violated by the parties of the war ,hence, it is highly important to study how effective the international instruments are.

Many international armed conflicts ended with having committed killed or permanently disabled or separation from their families.(Aary 2011:112-115) .Many ongoing wars and instabilities around the world ,the situation of children who are living in affected areas remains critically worrying and this situation raising a question whether the presently exiting legal framework to protect the children in armed conflicts provides effective remedies and adequacy of the available lethal framework to address the issue. On Oct.14 2023 more than 700 Palestinian Children reportedly killed in Gaza and more than 2450 children reportedly have been injured .(UNISEF 2023a) This issue had been documented by several researchers and this study aims to contribute to finding legal loopholes or in-adequacy of International Humanitarian law and the International Human Rights law specifically.

As the press release which has been made available by the UNICEF in the year of 2018 the nations have failed to protect children in armed conflicts (UNICEF 2018b) though there are many international instruments to protect child in armed conflicts namely Geneva Convention and Other International conventions specially human rights convention including ICCPR,ICSCR,CEDAW and UDHR .It has many years passed after introducing Geneva Convention and 30 plus years has passed after introducing Child Rights Convention. Very recently it is reported that there are many children had been killed and taken as hostages in the conflict between Israel and Palestine. In Syria in the year 2018 ,there are 1106 children had been killed in the fighting and additionally, there were many children being casualties, force to being combatants ,systematic sexual abuses and also being used as hostages or human shields.(UNISEF 2018a) There are many child abuse and violation of child rights had been reported in countries like Cameroon, Afghanistan, Iran, Iraq ,Congo, Eastern- Ukraine, Myanmar, Palestine, Somalia, South Sudan, Yemen ,Chad and it is established that civilian’s rights of affected areas and children rights had been deprived (UNISEF 2018b). This study

mainly based on the, The Fourth Geneva convention which is relative to the protection of Civilian Persons in Times of War (GCIV),The Third Geneva Convention relative to the Treatment of Prisoners of War (GC111),The Additional Protocol to the Geneva Conventions of 12th August 1949 relating to the Protection of Victims of International Armed Conflicts (AP-I), The Additional Protocol to the Geneva Conventions of 12th August 1949 relating to the Protection of Victims of International Armed Conflicts (AP-II),The Hague Conventions of 1899 and 1907. And Human Rights Laws namely Bills of Human Rights. This study a comparison of IHL and IHRL will be presented and their effectiveness analyzed based on the principles within the International Conventions and based on scholars opinions .Recommendations will be made based on scholarly opinions on how to improve and effectively better the protection provided for children in armed conflicts.

## 2. Methodology

The qualitative method is used for this research in order to collect information, especially secondary data will be used. The primary source are International legal conventions and treaties, whereas, secondary sources consists of a variety of scholarly articles and opinions based on legal researches. This qualitative study employs a legal method, known as Bert Lehrberg's legal work procedure which mainly comprised with six major steps from the point of identifying a legal issue to developing an argument,

1. Identifying and structuring a basic legal problem.
2. finding the right legal rules to address the issue.
3. reading and interpreting legal sources
4. identifying the necessary requirement in a legal rule
5. specifying the meaning of the necessary requirement with the support of legal sources.
6. taking an independent stand with the support appropriate interpretations.

Apart from the legal character of the analysis, the major arguments of legal scholars are also utilized to build an argument having touched upon a normative approach. The sources of materials come from legal problems it will focus on International agreements, treaties and conventions. No universal agreement on which falls under the definition of a child exists as the age limit differs from country to country .This study is limited to analyzing a certain number of International documents that are of the greatest relevance to answering the problem of the research.

## 3. Result and Discussion

The distinction between IHL and IHRL is very important as they differ in character and their applicability in different situations. IHL is applicable to non-state actors and IHRL is applicable to states and latter's rights are held headed for the state. Their responsibilities towards its citizens where therefore, non-state actors are often not address in IHRL and also not bound by Human rights law conventions and treaties.

In International law ,***jus ad bellum*** also refers to the conditions under which country may resort to war or to use of armed force, very recently in year 2023 as cited by Israel in its response, is

one of the justifications which had been made for the war, with the Article 51 of the UN Charter preserving the right to attack in the armed conflict. The exercise of right of self-defense is still comes under the International Humanitarian law. International human rights law is applicable all times ,including armed conflict situations in which the law of war apply as well as during the time of peace which include rights such as prohibition of torture ,inhuman and degrading treatment, non-discrimination, right to life and right to fair trial.

In relation to International humanitarian law, the Geneva Convention 1949 does not provide precise regards to children as it does not provide special statement on a need to recognize the vulnerability of children who are in the armed conflicts .Nevertheless, with the introduction of Additional Protocol 1(AP1) there is a clear statement that addressed the need of children to be treated preferentially due to their vulnerable nature, and that makes a wide umbrella under which children are said to have been protected, however, it is noted that the Additional Protocol 1 does not address factors concerning to protection of the children in an armed conflicts. Further, a major issue which can be found of the protocol is that the **'protection'** is loosely defined. Therefore, it seems that 'protection' under the protocol is a compromise between humanitarian standards and military necessity in the armed conflicts. So the ambiguity of this protocol is as long as military necessity is achieved, children's lives may be placed at a risk if the attack is considered as proportional. As the proportionality is considered as one of the major essentials of any armed conflicts. The other possible scenario would be when weapons or any arms (military weapons) are hidden by the combatants near any building or close-by to an object where children are kept, in this situation the attack target a military objective but due to its geographical location it may causes injury or may kill children, in this case, there are two possibilities ; one is that injury caused and loss of children's lives is un-intentional and even though attackers are aware of the presence of the children, therefore, the injury caused is not an aim but an un-intended result, anyhow children lives may loss. The other possibility is that the attacker aims to destroy the targeted military object together with civilian which includes children. In these two scenarios it is difficult to differentiate between the two different circumstances since the intention of the enemy can hardly be ever recognized, and this creates a difficulty and leaves room for violations. Another important issue is that weather is act can be considered a lawful reprisal. Under customary International Humanitarian law the act of reprisal was allowed even if it was carried out on the civilian population, but importantly, with the introduction of Four Geneva Convention it has been banned for civilian population on occupied territories (GCIV Article 33).

Introduction of the first additional protocol (API) 1977, the act of reprisal on the civilian population is completely banned. But many countries believe that since the reprisal is a useful way to discourage state to violate the law in the first place, therefore, effectiveness of the ban of reprisal civilian and children is still committing. Reprisals are forbidden but may be controversial since the intention of committing the act needs to be proven in each case and that is again very problematic, According to Additional Protocol-1 both the use of children as human shields and the act of reprisal on the civilian population are banned, but application of this provisions remains problematic.

Limitation of Protocol -11 can be divided into threefold, First one is there is no definition of civilians and combatants exist because of the sensitivity of sovereignty discussion which recognizes the independence of state, which discourage interference of foreign inventions. secondly, no explicit positive obligations to reduce civilian deaths exist, thirdly, prohibition of reprisals against civilians is not given consideration and mentioned in the protocol.it is noted that deliberate or intentional killings of children ,that are not within the areas of military targets are prohibited under IHL, but significantly, the situation becomes more difficult once either combatant/s are hidden among the civilian or when military objects or weapons are being

placed near to children/civilians the damages that could be collateral damages become very problematic. The most effective way which needs to be improved the protection of children under International Humanitarian Law is to be improved compliance with its legal provisions where its applicability should be simplified, expanded and adjudication by an impartial international legal mechanisms including international court should be implemented. Most states recognize right to life as a non-derogable rights according to the European Convention on Human Rights (ECHR) Article 15(2) *'no derogation from article 2 except in respect of deaths resulting from lawful acts of War'* this means if the war is defined as lawful, the act committed to arbitrary deprivation of life is allowed, and is not considered as a violation of rights. Therefore ,assumption can be made that IHL is superior, and children's right to life under IHRL is less generalize if the act of war is lawful therefore; deprivation of their lives are also considered as lawful. This means that right to life of children in certain situations is not considered as ***jus - cogens*** and deprivation of their life can be either lawful or accepted. The proportionality rule does not specify many core issues and leaves many un-answered questions; therefore it gives chances for states to violate children's rights. Many scholars argued that state party to the Convention the right of the child has to strictly follows the provision namely Article 38.para 3 or to API Article 77 Para 2. and should take legislative measures to protect children under 15 years. Many scholars argued that Article 1, Article 2 and Article 3 & 4 to the Optional Protocol to the Convention on the Rights of Child have not been given due concerned by the state parties. The major loophole found is the principle namely proportionality and military necessity can be used as instrument to justify the attack against civilians even though the attacks are willfully conducted against civilians having known that they are mere civilians ,this could only be identified whether the attacks were justiciable only having fair and just trial by the International Criminal courts (ICC) or International Criminal Tribunals .In the leading judgment of ***Galic Case*** in 2003,the International Criminal Tribunal for Former Yugoslavia (ICTY) the ICTY Trial Chamber stated inter alia: " *In determining whether an attack was proportionate it is necessary to examine whether a reasonably well-informed person in the circumstances of the actual perpetrators ,making reasonable use of the information available to him or her ,could have expected excessive civilian casualties to result from the attack"* (ICTY,*Galic Case* ,2003 .58) But again the loophole of International law come to force which is the decisions made by the Tribunals and other International Courts are not followed by some states and some state are not state party to International Criminal Court, so applicability of available International Human Rights Laws (IHRL) and Humanitarian laws (IHL) to protect children in armed conflicts become futile.

## 3. Conclusion

Countries who taking part in armed conflicts will follow their interest and it remains very important that international law takes a more effective approach to avoid many civilian causalities specially children as possible. Therefore, International Human Rights laws and International Humanitarian Law needs to be built up more binding force and answers to violation against the children .This has to be addressed separately as separate mechanism and provide better protection for children in armed conflicts. Another main issue that the conventions are not ratified by some states i.e. Israel denies the application of the Fourth Geneva Convention throughout its occupation in Gaza and West Bank (Red Cross 2018). Hence ,children who are under armed conflicts are subjected to many kind of violations and without any international protection they will suffer loss of lives and injuries ,therefore even having many international IHL and IHRL children are still subjected to many violation in armed conflict ,therefore lack of application of IHL and IHRL provisions by some countries can be identified and that shows the

loophole of International law ,therefore a comprehensive mechanism for ratification of International laws has to be implemented at least for the conventions which related to any armed conflicts. Therefore it is concluded that having International IHL and IHRL conventions are not adequate even though there are many adequate provisions for the protection of children in armed conflicts ,the application of the provisions of the conventions are paramount important. Targeting of civilians including children are still happening, therefore unless these issues are addressed, international conventions and treaties which is to protect children will remain futile. Therefore , the International conventions related to IHL and IHRL are not practically effective in protecting children, as many state parties in armed conflicts are not adhered to the conventions due to lack of legal binding power or have not yet ratified the conventions. Additionally, provisions relating to Proportionality and military necessity has to amended and strict rules have to be included otherwise combatants/state may justify their willful targets of civilians including children based on the principles namely military necessity and proportionality. It is recommended to initiate a mechanism by UN to monitor whether the state parties to adhere to the most crucial provisions of the International Humanitarian laws including : **Article 51(5)(b)** of the 1977 Additional Protocol - I (AP-I) (Prohibition of attack to civilians including Children) ,Article **85(3)(b)** of the AP-I (Prohibiting launching an indiscriminate attack effecting the Civilian Population including children), Article **26(3)(b)** of Additional Protocol – II (Draft) forbidden of launching attack which may be expected to entail incidental losses among civilian including children., Article **3(3)(c)** of the Protocol-II to the Convention on Certain Conventional Weapons (1980) which prohibits any placements of mines, body-traps and other devises which may cause incidental loss of civilian life ,which include children, Article **3(8)(c)** of the Amended Protocol II to the Certain Conventional Weapons which prohibits any placements of mines, body-traps and other devises which may cause incidental loss of civilian life ,which include children and pursuant to Article **8(2)(b)(IV)** of the ICC Statute, which banned intentional attack for civilians including children (which constitute a war crime)

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# The Significance of Economic, Social and Cultural Rights over Civil and Political Rights in Modern Sri Lanka: A Comparative Study on Human Rights

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## Abstract

The history of human rights starts with the moral standpoint of human nature in struggling to preserve their rightful place in society. The unofficial consensus in respecting others was present from antiquity, however, it only applied to the elite class and not to the plebians, proletariats, or slaves. In the past decades, a friendly rivalry has been created between the two covenants that were introduced under the universal human rights of all the members of the human family, with countries giving civil and political rights (CPR) a prominent place while giving less attention to economic, social and cultural rights (ESCR). However, in the current affairs of Sri Lanka, people tend to value ESCR more significantly than the CPR. CPR is viewed as a negative right that does not have any financial repercussions for governments because it seeks to compel states to implement beneficial social arrangements. On the other hand, ESCRs are viewed within the same structure as positive rights that have implications for state involvement; however, now there is no distinction between CPR and ESCR regarding the involvement through action and omission by the state. The economy of Sri Lanka began to collapse in early 2022 due to a shortage of foreign exchange, the COVID-19 pandemic, and the ongoing war in Ukraine. Moreover, the country implemented many restrictions on importation due to the limited foreign reserves. The writers would pinpoint the government's own economic mismanagement as one of the main reasons for the crisis, such as excessive borrowing and tax cuts that were made discretionarily justified as election promises. This led to widespread shortages and price hikes, which further exacerbated the crisis. In 2022, the government of Sri Lanka was forced to default on its foreign debt, which further damaged the country's reputation and led to widespread protests and unrest. The government has taken several steps to address the crisis, but it will take a lot of effort to rebuild the country's economy. These situations provided the researchers in this qualitative analysis with a conclusive answer as ESCR being prominent over CPR under the prevailing situation.

## Extended Abstract

### 1. Introduction

The history of human rights does not start with the emergence of the United Nations and its Conventions. Nonetheless, it goes way back to the antiquity of time. The foundation of Human rights is based on three main pillars; namely, 1) Dignity, 2) Equality, and 3) Respect. These pillar values derive from the moral standpoint of human nature in struggling to preserve their rightful place in society because there were no rigid policies on the humane treatment of all members of the human family equally. This tends to awaken the feeling of resisting and reacting to possible threats to their individual dignity. Therefore, an unofficial consensus in respecting others occurred, however, it only applied to the elite class and not to the plebians, proletariats, or slaves. With the evolution of man, who grew his sophisticated mind with technology, discipline, and rules as well as greed, aggression, and power hunger, greater achievements and greater threats entered the world with hazardous and destructive outcomes.

This paved the way for an international consensus on all states around the globe to unite their legal standpoint to a single human rights document named, the Universal Declaration of Human

Rights (UDHR) which consists of thirty Articles that focus on the inherent rights of all human members, rights which ought to be protected and safeguarded by the government, rights that could be claimed against a government and the facet of universality. (Qureshi, 2018) The declaration includes civil rights, political rights, economic rights, social rights, and cultural rights more or less without any general division. However, the UDHR was a mere declaration of rights and did not have any binding power or enforcement towards infringements of rights. This created an urge to create in-depth legal documents that focused on the above-stated rights and therefore, international segregation arose, dividing the rights into two factions. Civil and political rights (CPR) were represented through the International Covenant on Civil and Political Rights (ICCPR); and Economic Social and Cultural Rights (ESCR) were represented through the International Covenant on Economic, Social and Cultural Rights (ICESCR).

A friendly rivalry has been created between the two covenants in the past decades in questioning what rights are superior to the other and many international instruments, regional agreements, and constitutions indicate a bias toward CPR giving less attention to ESCR. However, when considering the current affairs of Sri Lanka this could be identified with a different approach, where people tend to value ESCR more significantly than the CPR in its desperate situations that affected the lives of the people tenaciously. Therefore, this will be analyzed through several major incidents that occurred during the past couple of years and currently facing. This includes the corrupted political regime in the country, the COVID-19 pandemic, the banning of chemical fertilizer, the economic crisis, and the new beginning after being a bankrupt country.

## 2. Methodology

This qualitative research involves both primary and secondary sources including, case laws, statutory provisions, books, journal articles, and other online resource materials. The main focus of this research is on the Economic, social, cultural, civil and political rights based on the ICESCR and ICCPR Conventions of the United Nations. This would focus preliminarily on the significance of economic social and cultural rights over civil and political rights in the Sri Lankan standpoint and thereafter its practical examples.

## 3. Results and Discussion

### 3.1 Origin and Development of ESCR and CPR in Sri Lanka

In order to understand the present clearly, a deep evaluation of the past must be done on the origin and the track of development to this date. As an island nation, Sri Lanka was a prosperous country with its resources and riches. This is elucidated in the case of *Bulankulama and Others vs. Secretary, Ministry of Industrial Development and Others,* (Bulankulama and Others vs Secretary, Ministry of Industrial Development and Others, 2000) where Amerasinghe, J. points out a statement made by Judge C.G. Weeramantry in the case of *Hungary vs Slovakia,*

"…the irrigation works of ancient Sri Lanka, the philosophy of not permitting even a drop of water to flow into the sea without benefitting humankind, and pointed out that sustainable development had been already consciously practiced with much success for several millenia in Sri Lanka…the notion of not causing harm to others and hence *sic utere tuo ut alienum mon laedas* was a central notion of Buddhism. It translated well into environmental attitudes." (Bulankulama and Others vs Secretary, Ministry of Industrial Development and Others, 2000)

This shows that Buddhism as a religion has had a considerable effect on molding the Sri Lankan citizenry into somewhat morally prudent. Therefore, before the colonial period, Sri Lanka had a customary and religious bond in human rights that contributed to the betterment of citizens while providing with needs such as food, water, shelter, medicine, and cultivation lands. Even though

there was a monarchical ruling in the country, religion had the utmost supremacy with a preliminary focus on the citizen's well-being.

Sri Lanka was situated in the 'Silk Road' which was an intricate web of sea trade routes that connected East Africa, the Middle East, Europe, and South, East, and Central Asia in the classical era. Furthermore, as to Prof. J.M. Sudharmawathie, Sri Lanka had long served as the Indian Ocean's primary international commercial landmark and since antiquity times, Sri Lanka has served as the principal meeting place for merchants shipping goods from the East and those arriving from the West via the Persian Gulf and the Red Sea. (Sudharmawathie, 2017) This unlocked a new connection with foreign aliens to have successful trade and commercial relations. However, it did not gain priority over the self-sustaining economy that Sri Lanka had through aswaddumization. With the arrival of the Westerners, the societal and cultural aspects of the country were nurtured with economic values that were based on their well-being and their prospective gains.

When looking at Civil rights in early Sri Lanka there was rule by law that was supplemented through the discriminatory actions of the monarch. The King was the sole executive, legislative, and judicial power holder of the state which threatened the existence of proper rights such as the right to life, and the right not to be tortured, enslaved, or arbitrarily imprisoned. It must be noted that there was polygamy and polyandry present in the Sri Lankan cultural marriage system that was contrary to Western culture in modern times. With regarding the standpoint of the political right in Sri Lanka, L.J.M. Cooray states,

"Early contracts existed with Rome, Egypt, and China, and Commercial and Political connections with South India appear to have been common." (Cooray, 2017)

With this, it is evident that there were indeed political rights and diplomatic connections in early Sri Lanka. When considering the modern-day approach to these rights, is mainly supplemented through the Constitution of the Democratic Socialist Republic of Sri Lanka, and is supplemented with a number of ratified international treaties including the following:

- International Covenant on Economic, Social, and Cultural Rights (ICESCR)
- International Covenant on Civil and Political Rights (ICCPR)
- Convention on the Rights of the Child (CRC)
- Convention on the Elimination of All Forms of Discrimination against Women (CEDAW)
- International Convention on the Elimination of All Forms of Racial Discrimination (ICERD)
- Convention against Torture and Other Cruel, Inhuman or Degrading Treatment or Punishment (CAT)
- Convention Concerning the Prohibition and Immediate Action for the Elimination of the Worst Forms of Child Labour
- Convention for the Suppression of Traffic in Persons and of the Exploitation of the Prostitution of Others.

### 3.2 Modern-day Significance of ESCR over CPR

When considering the modern trends of human rights, many legal scholars have divided these rights as positive and negative with their focal point questioning the interference of government. CPR is viewed in this perspective as a negative right that does not have any financial repercussions for governments. Negative rights, such as the right to assemble, the right to be free from slavery, and the right not to be tortured, all merely call for governmental inaction; because they seek to compel states to implement beneficial social arrangements. ESCRs are

viewed within the same structure as positive rights that have implications for state involvement through funds. For instance, the right to education and the right to a basic standard of living both call for state action and resource allocation. (Foster, 2008) However, this is not true at all times because it could not by no means be simple to understand as negative and positive aspects of CPR and ESCR, respectively with modern trends of law. For instance, while some CPRs have no resource allocation or have a negative impact, others might impose significant expenses on governments as positive obligations. On the other hand, there are specific circumstances where ESCR cannot entail financial consequences or call for proactive government action. Because both types of rights can have either positive or negative outcomes, the idea that there is a clear distinction between CPR and ESCR regarding action and omission is erroneous and ambiguous. (McLean, 2009) The superiority of CPR was solely concerned with this fact of negativity, yet, when analyzing the modern context there is no distinction as to what has gained prominence. However, it could be argued with the present affairs of the country, Sri Lanka has given more prominence to ESCR and it will be justified in the next part of the paper.

### 3.3 Corruption and Malpractice

Even though there is no specific definition for corruption, it could be simply identified as the abuse of entrusted power for private gain. (Prasad & Eeckeloo, 2019) Bribery and corruption are twin evil forces that cause hardship to any person who is empowered with authoritative power in a country. In the year 1887 Lord Acton wrote a letter to Archbishop Mandell Creighton stating that every person should have the same moral standard even if he was an ordinary citizen, political leader, or religious leader; and further stated that:

“Power tends to corrupt and absolute power corrupts absolutely. Great men are almost always bad men, even when they exercise influence and not authority: still more when you superadd the tendency or the certainty of corruption by authority.” (History Department : Hanover College, n.d.)

Even though this was written more than a century ago, its values still apply in the same manner compared with modern times. It is clear that many malpractices and corruption clearly violate Article 2(1) of the ICESCR where it makes difficult and impossible to achieve and provide for its vested state obligations. (International Covenant on Economic, Social, and Cultural Rights, 1976) Therefore, the state has a duty to prevent corruption and take means of anti-corruption measures. Corruption always directly affects the country’s economic and political sphere; however, even if there are comprehensive legal frameworks of anti-corruption such as public auditing that help in reducing corruption and ensuring transparency, it will not fully terminate the corrupt state affairs. Moreover, the judicial system of the country has also developed jurisprudence in this area while highlighting the rule of law and the fact that powers must be held in public trust. (Transparency International Sri Lanka, 2008)

Government funding is occur mainly through the mass economic development projects that the government initiates mainly through a joint venture with foreign investment, however, there are many other ways that this could happen in the country that affect the well-being of the people in the country. The case of *Malikage Padma Wijesooriya and Another vs. Thilekaratne alias Loku Aiya and Others (Speed Limit Case)* case provides that at first sight evidence that in instances such as bribes, the superiority of CPR gains importance however, the big picture can be focused on the economical aspect. The petitioner in this case has manufactured and sold illicit liquor while bribing the Puttalam police and Saliyawewa police post in order to turn a blind eye to this event.

### 3.4 The Covid-19 Pandemic

Sri Lanka confronts various obstacles in the fight against COVID-19, just like many other nations. The pandemic has created a great deal of uncertainty and put the nation's healthcare system up against enormous obstacles. Sri Lanka started to experience a shortage of medical resources, such as hospital beds and medical equipment, as a result of the sudden rise in cases and the appearance of new varieties. Early on, the vaccination program encountered a number of issues because of the intermittent and erratic supply of vaccinations, the disorganized deployment, and the departure from the scientifically accepted prioritization.

The COVID-19 pandemic situation affected the day-to-day lives of people and due to that reason, it affected many Economic, social, and cultural rights. Namely: Right to work. Right to social security, Right to an adequate standard of living, Physical and mental health, Right to education, and Right to take part in cultural life. Because people were unable to attend to their usual work certain corporations terminated many workers as a result of the Covid pandemic. Due to covid 19 pandemic to protect and uphold the right to education, governments authorized schools and other educational institutions to follow online education systems. However, no remedy was provided to rural areas that lacked the necessary technology and equipment to participate in educating themselves through this online learning platform.

It also heavily affected the right to health and the government attempted to provide health services and provided vaccination programs to maintain the health of citizens. More than 12 million Sri Lankans, or 55 percent of the population, have received at least the first dosage of the vaccine by mid-August 2021. (Institute of Policy Studies of Sri Lanka, 2021) In addition to the delayed supply of vaccines, there were difficulties with the prioritization of vaccinations and obtaining regulatory authorization for vaccine usage. Due to the lack of an online appointment system and a properly planned method for vaccine deployment, many people were also spotted waiting in line at vaccination centers, increasing health hazards.

The government has lately implemented various improvements to the rollout, including speeding up the procurement procedure and enhancing administration with the aid of defense services. This could be recognized as an instance where CPR has gained secondary prominence. Nonetheless, it was evident that with the recognition given to the right to health, right to work, right to education, etc., ESCR has more significance during this period in Sri Lanka.

**3.5 The Banning and Limiting of Chemical Fertilizer**

The national Gross Domestic Product (GDP) is largely comprised of the agriculture sector, which accounts for 7.4 percent of it, and agriculture accounts for the employment of more than 30% of Sri Lankans. Efficiency is key when discussing the benefits of fertilizer use in agriculture and chemical fertilizers enable farmers to increase the agricultural yield on a particular plot of land; the more the plant grows, the better. Fertilizer helps each plot of land produce as much as it can while chemical fertilizers can even make otherwise poor-quality land produce sizable yields if you know how to use them.

However, on May 06, 2021, the then-President together with the Minister of Finance imposed restricting and banning of fertilizer and agrochemicals under the Imports and Exports (control) Regulations No 07 of 2021 with its effective publication in the gazette No. 2226/48 of May 06, 2021. This sudden decision was justified as a presidential election promise made by the president; however, this led to widespread concern among the farming community, industrial association practitioners, and agricultural professionals but the Minister of Agriculture gave assurance to the farmers that the government would purchase paddy rice crops and gave assurance to the consumers that no price change would occur. It must be noted that there are indeed many benefits derived from this decision such as helping with mitigating the highly increasing health risks such as Chronic Kidney Disease and environmental pollution. However, the question arose with the sudden banning that gave no solution to the people on how to fill the gap that chemical fertilizer filled before.

Through this many rights of the people were violated such as the right to work, the right to just and favorable conditions of work, the right to social security, the right to protection for the family and children, the right to an adequate standard of living and right to take part in cultural life. It can be clearly pointed out that this sudden decision affected the ESCR preliminarily while creating an ascendancy that threatened the government to take positive actions in providing adequate fertilizer and agrochemicals. However, within a limited framework of time, the government had to close down the restrictions on the importation and distribution of chemical fertilizer due to the shortage of food and the outburst of rage of farmers towards the government.

### 3.6 The Economic Crisis.

Due to a number of factors, the economy of Sri Lanka began to collapse in early 2022, when the country experienced a shortage of foreign exchange. One of the main reasons for the economic crisis was the sudden appearance of the COVID-19 pandemic, which had a negative impact on tourism and remittances. The tourism industry is a major source of foreign exchange in Sri Lanka and it was severely affected by the pandemic where there were many restrictions on movement. Moreover, the government's revenue from taxes and other sources also declined due to the pandemic. The second reason for the economic crisis is the ongoing war in Ukraine against the Russian Army, which even though it did not directly affect Sri Lanka, caused a rise in global oil prices that created a fuel crisis in Sri Lanka and further, the war gravely disrupted global supply chains, which has made it more difficult for third-world countries such as Sri Lanka to import essential goods. Moreover, because of the fact of limited foreign reserves, the country implemented many restrictions on importation as well. (Central Bank of Sri Lanka, n.d.)

As one of the main reasons, the writers would pinpoint the government's own economic mismanagement, such as excessive borrowing and tax cuts that were made discretionarily justified as election promises. With the end of the civil war against the Liberation Tigers of Tamil Eelam, the then government borrowed money heavily from foreign countries such as China and started new mega projects on a credit basis. This method was followed by the subsequent government as well and therefore, this has led to a large debt burden, which has made it difficult for the government to finance its day-to-day operational needs that were even essential. It must be noted that taxes are the main source of income for a government and the cut taxes, reduced the government revenue which affected majorly to the free healthcare policy to a greater extent. As a result, Sri Lanka was unable to import essential goods, such as fuel, shelter, food, and medicine which are considered as basic needs of Sri Lankan citizens. This led to widespread shortages and price hikes, which further exacerbated the crisis. In April 2022, the government was forced to default on its foreign debt for the first time in its history and became the first Asian Pacific country in this century to debt default. This further damaged the country's reputation and made it even more difficult to borrow money which has had a devastating impact on the Sri Lankan people. Millions of people have been plunged into poverty, and there have been widespread protests and unrest that demanded the government fulfill peoples' ESCR.

### 3.7 Current Situation

The government has taken some steps to address the crisis, such as seeking financial assistance from the International Monetary Fund (IMF). However, the crisis will likely continue for some time, and rebuilding the country's economy will take a lot of effort. Even though this situation seems normal, Sri Lanka is still in a fragile state when considered economically. The bailout package given by the IMF is under a number of economic reforms and this includes reduction of government spending, tax raise, and privatizing government enterprises that are a burden to the government in this critical stage. The government with its limited reserves and abilities has to answer several major issues such as high debt, foreign exchange shortage, high inflammation, unemployment, and poverty. (International Monetary Fund, 2023)

The rationale behind all these factors lies within the scope of ESCR hence the importance of CPR is there, and they also tend to focus on strengthening the ESCR. The political regime of the country is also focused on the well-being of the citizens, rather than having elections in order to fulfill other essential needs of people; however, there are other opinions as well on this matter. It is too early to hold an answer to the question of whether Sri Lanka will be able to fully recover from the economic crisis. (International Monetary Fund, 2023) However, the government is making some progress, and there are signs that the economy is improving. In this process, the Sri Lankan government faces several challenges in protecting and promoting ESCR. However, it is important to remember that these rights are essential for the well-being of all Sri Lankans and therefore, the government must take steps to address the challenges and ensure that everyone can enjoy their rights.

## 4. Conclusions

As per above, it is clear that ESCR has gained prominence over CPR due to particular incidents and situations the country has faced which have underscored the significance of ensuring access to basic needs such as food, education, health, and shelter. Therefore, it is taken up to address the ESCR through prioritizing to uplift the vulnerable population and foster socio-economic development in the country. Even though these rights are segregated into two main pillars, it must be noted that they are tied up together with each other. Even though one group becomes prominent, it will not diminish the usage but it is also necessary for the overall well-being and dignity of all members of Sri Lanka.

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# BLACK LETTER LAW VS. JUDICIAL ACTIVISM AND ITS INFLUENCE ON EXISTING LEGAL CONTEXT

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## Abstract

Most of the states have been empowered with their own sovereignty powers to enact laws and regulations through their judicial mechanisms. There are different judicial systems that follow inquisitorial and adversarial procedures. Hence, some court systems have enhanced their powers via judicial activism, and some courts have tended to follow black letter law by following the legislation as it is. These two methods constantly have an adverse impact on the administration of justice due to the influence of judicial activism. Even though it seems unfair, courts that follow black letter law have to stay by folding their hands, as the only thing they have to do is follow the enactments without involving the actual aim of the judiciary. As well as the courts that have been empowered with judicial activism, would make unfair decisions by using their discretionary powers while experiencing ultraviolence. Such instances have been recognized by referring to some case laws from the judicial systems of various countries. The qualitative method was used to analyze the data based on an argumentation approach by referring to the multi-disciplinary perspectives of philosophers and scholars. Hence, 'absolute power corrupts absolutely', judicial power should not be allowed to act with absolute power. But uncountable restrictions on judicial operation would amount to affect the due function of administration of justice that can be recognized as the prime requirement of the judiciary. Hence, a regulatory body or any other intervening party should be established to mitigate the constant conflicts between the judiciary and the law-making body where judicial activism is operated in a higher manner. Such third-party intervention may reduce the conflict by allowing the cases to be decided without prejudice. Further, the loopholes that arise due to unexpected situations should be addressed by involving the body, as it would prevent causing injustice to any single person, including differently abled people who are suffering from mental disabilities.

Key words: judicial activism, black letter law (positivism), locus standi

## Extended Abstract

## 1. Introduction

Every state has an obligation to develop a mechanism to protect the human rights of its citizens who reside within its territory. There are instances where the state is bound to protect the rights of persons who are not permanent residents of its territory. Most of the states that follow the constitutional system have taken steps to include such rights in the constitution, which is embodied in the rights and duties of a particular government and its function. Dualist countries may follow international instruments such as covenants and treaties that direct the respective states to follow the guidelines that are specified in such instruments. Hence, fundamental rights have been recognized by the states to protect the liberty of the people, including citizens as well as non-citizens. Executing these rights via dispensing justice is done by the judiciary of the particular state. But instances can be recognized that make the parties prejudiced due to their various backgrounds. Judicial activism is a pivotal background that may institute unjustifiable decisions due to the absolute independence of the role of the judiciary. But when there is a situation where the injustice is clearly shown, the judiciary cannot execute such an injustice simply by emphasizing its scope and restrictions. Thus, this research, at its initial steps, focuses on looking into the instances where judicial activism and black letter law create conflicts within the existing judicial context by referring to decided case laws.

And also, it aims to recognize the instances where such incompatibilities can arise and how such adverse impacts affect the existing legal contexts. Different philosophers from different law schools have been considered in this regard, especially the views of H.L.A. Hart and Jeremy Bentham and the creative views of Lord Denning. Case laws have been brought to attention to highlight the practical instances where the impacts of judicial activism are in operation. As the most detected area, fundamental rights violation cases have been specified by referring to Sri Lankan cases that make prejudice to the respective petitioners by treating them in an unequal manner. Further, the research moves to identify the actual issue pertaining to the arisen prejudice, and it intends to recognize and suggest remedies for the issue by highlighting the necessity of a specialized body or entity to intervene in the matter in conflict. A legislative body drafts laws that can be executed before the expected situation occurs. But such a law is not in a position to cover all the instances that can arise in that regard. In such situations, judicial activism may mitigate the prejudice by filling the gaps. But extraordinary intervention by the judiciary may distort the intention of the law-making body, and it would cause ultra-violation. This research focuses on showcasing such instances by analyzing the facts, ratio decidendi, and dictums of decided cases as the second step. Further, it moves to

make suggestions to harmonize the constant conflict between judicial activism and the black letter law. Finally, research states some gray areas that have not been taken into consideration (by responsible entities) within the ambit of the selected topic, and it emphasizes the importance of establishing a specialized intervening body in this regard as it would directly support upholding the ultimate goal of the judiciary, 'Administration of Justice'.

## 2. Methodology

The research is totally based on secondary sources. The collection of information has been done by referring to the works of philosophers and legal scholars, such as Hart H.L.A., Austin J., Bentham J., Cardozo B.N., and Denning J. The analysis has been done by following the commonly used approach:

1. The identification of the issue (legal question): identification of the impacts that can have adverse effects on the existing legal context due to the constant conflict between judicial activism and black letter law
2. Applicable rules: identification of applicable rules to judicial activism through referring to interpretation rules and theories
3. Application of related rules: discussing the application of such theories and rules in judicial function
4. Conclusion with recommendations and interpretations: supposed suggestions that can be used to eliminate the arisen issue with regard to the incompatibility of judicial activism and black letter law

Through the research, the drawbacks and loopholes that have been caused by the arisen issue are addressed, and supported evidence is analyzed with the dictums and opinions of the scholars. As a final step, recommendations have been proposed to overcome the constant conflict between judicial activism and black letter law.

## 3. Results and Discussion

The states that follow the constitutional system most probably depend on a check and balance system. Thus, the equal distribution of powers between such principal organs should be performed in a proper manner. In some instances, the legislature cannot address such an issue without the support of the judiciary, as the execution of the drafted legal provision is vested in the judiciary. Hence, when an extraordinary situation arises, a proper combination

between the law-making authority and the law-executing authority is mandatory. Both authorities should intervene in the arisen issue and make a solution by referring to their capabilities. But there are plenty of instances that can be identified where these authorities act individually without making collective decisions. It causes irreparable damage to the function of law enforcement authorities, as the individual decisions that are taken by respective authorities automatically violate their limits. Such ultra-violation would cause an imbalance of separation of powers among the principle organs of the government. As a pivotal instance, judicial activism can be detected as it allows the judiciary to justify decisions that have adverse effects on the legislature. But it is obvious that the legislature is not capable of making a law that can cover both expected and unexpected situations. Hence, the judiciary is the responsible entity that should fill the gap in such legislation. Thus, it is crystal clear that both entities should engage in the functions of lawmaking and execution concurrently. Both institutions should run relays on the same track as partners of the same team to win the race for the administration of justice. These institutions should not run separately as contestants in the same race, as it would damage the ultimate goal of their function, 'administration of justice'.

While performing its duties, it seems that the judiciary has a special immunity in practical context to alter the legal provisions via the interpretation process. Sometimes, it helps to prevent injustice. But due to the discretion of the judges, the interpretation process can be done according to the perspective of the judge. It allows the judge to seek in to the case by the side of his preference, and justification can be done according to such a view. Hence, different judges may give different judgments based on their discretion and perspectives. This would damage the prime characteristics of law, such as certainty and predictability. In the cases of *Somawathie v. Weerasinghe (1990) SC 227/88 and Sriyani Silva v. Iddamalgoda (2003) SC 471/2000,* the different judgments showcase the positive and negative impacts of judicial activism. Merely imposing restrictions on judicial activism is not sufficient to eliminate these impacts, and it would allow the black letter law to be operated in a pure manner. The pure operation of black letter law may create absurdities and ambiguous instances by dispensing unjust decisions. Though certainty and predictability are continued, the ultimate goal of the law, 'social justice', will be withering away. Thus, a combination of relevant authorities and their participatory decisions would be the best solution for the unjust situations that arise due to these adverse effects. A proper combination between the legislature and the judiciary takes appropriate measures to balance the functions of particular authorities by intervening in the administration of the justice process where necessary.

Hence, a specialized entity is highly required to maintain said combination for the duly performed administration of justice. Further, the specialized body shall intervene in instances

where gaps emerge in the process of lawmaking and execution. It shall cover the gray areas that are not addressed by both the legislature and the judiciary. Thus, the necessity of such an intervening body can be identified as the most compatible solution to eliminate the constant conflict between judicial activism and black letter law.

## 4. Conclusions

The ultimate goal of the law is to achieve social harmony by maintaining law and order. The people who are benefited by these laws shall have the ability to predict the consequences of legal provisions. To predict such consequences, the certainty of the law should be stabilized. But, due to discretionary powers and other intervening capacities, the judiciary causes alterations to the existing law. Sometimes it affects the existing legal system positively, and sometimes negatively. If such interventions influence the certainty and predictability of the law in a negative manner, irreparable damage is caused to the existing legal system via ultraviolence. But neither the legislature nor the judiciary have taken the necessary steps to mitigate such damages due to the gap that arises when applying said laws to unexpected situations. Incapacitated legislation that does not address all the possible instances in a particular area has to be applied to the unexpected matter at hand by the judiciary. Thus, the judiciary cannot simply turn back and stay silent at such moments by pointing out the legislature. The judiciary may apply the existing legal provisions *mutatis mutandis* to the matter at hand without allowing the gaps to stand as barriers to administering justice. But the overall impact of such interventions by the judiciary would affect the check and balance of the principle organs of the state by exceeding its boundaries and limits. Hence, to eliminate this issue, a specialized intervening body should be established that can fill the gaps that arise in unexpected situations without affecting the powers of the principle organs and their proper functions. There are plenty of instances where the judiciary is not in a position to amend the legal provision to be fit for the matter at hand. Such laws can be amended only by the legislature, and that process is not lenient. Thus, the final result of this issue will vanquish the prime expectation of the law. Therefore, the active interference of a third intervening party arises, who can act as a bridge to make a combination between these two authorities to harmonize the damage that occurs. Such a specialized third party may consider the views of both authorities and take appropriate measures to eliminate the conflict while preventing the cause of ultraviolence. Thus, third party intervention in this regard may stand as a pivotal body that serves for the function of administration of justice by harmonizing the constant conflict between the judicial activism and black letter law that are taken place due to various incompatibilities.

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## 8th INTERNATIONAL CONFERENCE ON MULTIDISCIPLINARY RESEARCH 2023

Session 04

**Management**

# IMPACT OF BOUNDARYLESS CAREER ATTITUDES ON CAREER SUCCESS OF EMPLOYEES AT A BUSINESS CONSULTANT FIRM IN SRILANKA

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## Abstract

Over past few decades regardless of huge number of models seeming to enlighten contemporary careers, boundaryless careers have grown to be extensively recognized in the literature. Boundaryless career concept has been tested as employee career success form. As a result, career literature holds contradictory arguments and less empirical evidence. This research study goes into discover how boundaryless career attitudes impact on career success of a business consultant firm in Sri Lanka. The adopted methods according to saunder's research onion for this study are positivism, deductive, survey, mono method, cross-sectional and primary data collection technique. Online survey questionnaire were distributed to 100 individuals in the business consultant firm utilizing random sampling method. Reliability analysis was done and data analysis was carried-out using descriptive statistics, correlation analysis and regression analysis. The end-result of this research study divulged that boundaryless career attitudes have a significant positive relationship with career success and significant impact of boundaryless career attitudes on career success. Furthermore, boundaryless mindset and organizational mobility preference were positively related to career success, while boundaryless mindset showed positive impact on career success and organizational mobility preference showed significant impact on career success. The finding of this research study concluded that being an individual with boundaryless career attitude show effect in increased career success in the form of career satisfaction. Finally, this study recommended that it will be more beneficial for employing firm to grant advanced opportunities for career growth with superior career management.

***Keywords***: boundaryless career, boundaryless career attitude, career success, career satisfaction.

**Extended Abstract**

## 1. Introduction

Increased global economy, severe technological progression and altering organizational structure has showed effects in transition onto flexibility in relationships among employee-and-employer and less predictability in the way of a person's career pattern. The word career is going through constant evolution and this is forcing workforces to take own charge of their own career progression, snatching career progression chances without traditional organizational boundaries. The path of traditional career which was popular few decades ago isn't completely dead, but not a norm any longer in this current globe that is severely advanced for an ample of the workforce. There are arguments about workforces' careers and the argument is that the workforces' careers are turning into becoming severely boundaryless and has decreased the dependability onto traditional organizational career management. The concept boundaryless career gives insight onto recognizing the way person might approach his/her own career. Boundaryless career pattern shows an independent path going beyond one employment boundary.

For the last few decades, researchers have attempted and aimed in understanding the concept, root and cause of boundaryless career to evaluate its implications for a personal career development, managing the organization and progress of community, so this sounds familiar in organizational literature. Existing literatures have concluded the positive relation of boundaryless career attitude with the outcomes including work passion, organizational commitment and job satisfaction. With the understanding about literature, there is a call by previous authors and career model needs empirical testing, as there exists a remarkable gap in literature on impact of boundaryless career attitudes on career success as there is limited understanding on how boundaryless career attitudes impacts career outcomes. Limited studies are available on the effects of boundaryless career on subjective career success indicators and those findings are lesser conclusive. Due to many various reasons there's requirement for studies in exploring contemporary career options, by boundaryless career attitude and paying attention on to career success in the form of subjective career success rather than objective career success is relevant.

Consequently, as there is a noteworthy gap in literature on finding-out how is the impact of boundaryless career attitudes on career success, in current research boundaryless career attitude will be digged-in as single dimension. This study will utilize subjective path for career success. This research study addresses the knowledge gap in the literature of career on how boundaryless career attitudes contribute to career success in a business consultant firm in Srilanka. In the career literature evidences and contradictory arguments, there is a knowledge gap on this topic and previous scholars' have made are less conclusive if there exists either positive or negative on the relationship with boundaryless career attitudes and career success.

Firstly "boundaryless" career concept was put forward by Arthur in (1994), further through the studies put forward by Arthur and Rousseau in (1996) this concept gained its increased reputation. Arthur and Rousseau highlighted that people precede their career beyond organizational boundary and introduced "boundaryless career" as the new perspective to the career management. "Boundary" is a synonym of bound and means limitation or else restriction, suffix "less" means without or free from. When considering "boundaryless career", it means either a career without limitations to area in which can extend. Boundaryless career (BC) might be represented by the messenger of god the Mercury, who is also god of commerce and patron of travelers and can fly very speedily, winning distance and barriers through effortless and quick moving to wherever desired (Kerr Inkson, 2006). Boundaryless career's focus is in crossing the terms of career such as objective and subjective. Sullivan and Arthur (2006) made a differentiation with "physical" referred as career movements and

change across boundary and "psychological mobility" referred as a person's psychological orientation to making movements. Psychological mobility's direct measure is the scale of boundaryless career attitudes. Boundaryless career attitudes (BCA) referred as "sequence of job opportunities that go beyond the boundaries of single employment setting" (Defillippi and Arthur, 1994). BCA underscores the contemporary view of careers as expanding beyond boundary of one firm (Stauffer *et al.*, 2019). BCA includes dual terms that compose the base of this model: (1) a Boundaryless Mindset (BM) (e.g. one's psychological mobility), (2) an Organizational Mobility Preference (OMP) (e.g. people's physical mobility) (Briscoe, Hall and Frautschy DeMuth, 2006).

The old trend of career success (CS) evaluation with organizational career and upward motion of successes have expired (Enache *et al.*, 2011). The willingness of taking responsibility over self career progression and career success evaluation are being followed by people currently through their perspectives (Enache *et al.*, 2011); (Herrbach & Mignonac, 2012); (Kurtuldu and Özçelik, 2023). In the contemporary penning about careers, the dual career success terms (1) Objective and (2) Subjective have gained significant attention as key outcomes of one's career experience (Arthur, Khapova and Wilderom, 2005). Subjective career success has usually been measured as unidimensional career satisfaction or perceived career success in the empirical studies (Greenhaus, Parasuraman and Wormley, 1990); (Briscoe Jon P. et al, 2021).

According to past research studies, it revealed that boundaryless mindset generally was found to have positive effect on career success, where organizational mobility preference was found to have positive and negative effect on career success and subjective satisfaction (Guan *et al.*, 2019). Since, there exists a considerable impact of career success on workforces and workplaces the importance of this study is placed on how boundaryless career attitudes impact career success of employees in a business consultant in Srilanka.

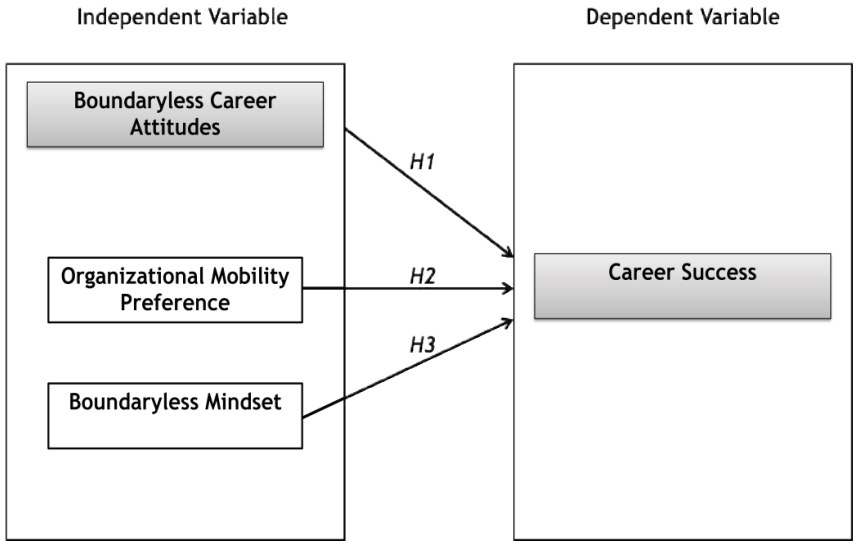


Fig. 1: Conceptual Framework

## 2. Methodology

The adopted research philosophy is positivism, adopted research approach is deductive, and survey method was chosen as research strategy, adopted research methodological choice is mono method, cross-sectional was chosen as the time horizon and primary data collection technique was adopted as data collection technique. The target population was workforces working in a business consultant firm in Srilanka. Sample size was 100 workforces working in the firm. Random sampling method was chosen as the most appropriate type. Self-administrated questionnaire was utilized.

**Table 01**. Objectives and Data Analysis Methods.

| **Objectives of this Study** | **The Analysis Method** |
|---|---|
| To identify the existing nature of boundaryless career attitudes and career success | Descriptive Statistics |
| To identify the relationship between boundaryless career attitudes on career success | Correlation Analysis |
| To discover the impact of boundaryless career attitudes on career success | Regression Analysis |
| To identify how the attributes of boundaryless career attitudes contributes to career success | Regression Analysis |

## 3. Results and Discussion

**Objective ONE: To identify the existing nature of boundaryless career attitudes and career success**

**Table 02**. Mean and Standard Deviation of Variables.

| **Variable** | **Mean** | **Standard deviation** |
|---|---|---|
| Boundaryless Mindset | 3.7015 | 0.25956 |
| Organizational Mobility Preference | 3.6941 | 0.28550 |
| Boundaryless Career Attitudes | 3.6425 | 0.41758 |
| Career Success | 3.8165 | 0.44637 |

Boundaryless mindset's mean value and std. deviation are 3.7015 and 0.25956. The mean value imply that workforces employing in business consultant firm in Srilanka are agreeing "to a considerable extent" to the existing situation of boundaryless mindset career attitude. Organizational mobility preference's mean value and std. deviation are 3.6941 and 0.28550. The mean value shows that workforces employing in business consultant firm are agreeing "to a considerable extent" to the existing situation of organizational mobility preference career attitude. Mean and std. deviation of boundaryless career attitudes are 3.6425 and 0.41758

respectively. This imply that workforces employing in business consultant company are agreeing "to a considerable extent" with the existing situation of boundaryless career attitudes. Mean value and std. deviation of career success are 3.8165 and of 0.44637. This shows that workforces employing in business consultant firm "agree" with the existing situation of career success.

**Objective TWO: To identify the relationship between boundaryless career attitudes on career success**

**Table 03**. Correlation between BM, OMP and BCA with CS.

| **Variable/Dimension** | **Pearson Correlation** | **P – Value** | |
|---|---|---|---|
| Boundaryless Mindset | 0.333** | 0.002 | (*r* = .333, *p* = .002) |
| Organizational Mobility Preference | 0.331** | 0.002 | (*r* = .331, *p* = .002) |
| Boundaryless Career Attitudes | 0.269* | 0.013 | (*r* = .269, *p* = .013) |

The output shows the positive correlations with employee and organization. Researcher identified that the relationship with boundaryless mindset and career success, relationship with organizational mobility preference and career success and the relationship between boundaryless career attitudes and career success are positive and significant correlations. These findings are consistent with previous researcher's findings.

**Objective THREE: To discover the impact of boundaryless career attitudes on career success**

**Table 04**. Regression Results of Boundaryless Career Attitudes and Career Success.

| | **Regression Analysis Results** | **As per information obtained through regression analysis, model of simple linear is expressed as:** |
|---|---|---|
| Boundaryless Career Attitudes and Career Success | *ß*=0.287, *p*=0.013 | $CS=2.770+0.287BCA+\varepsilon$ |

Researcher of this study as per output results reveals that BCA forecast career success, where there is a significant impact. This study's findings also reveal that the impact is positive. From the findings it is probable to state that workforces with BCA will be more aware of career success. Business consultants showed greater score of career success. In Boundaryless career approach, career success is most important part where it's vital for everyone to assess their personal careers and manage own careers. The finding of this study is not consistent with past research results since those findings showed a not significant relationship with BCA and career success. This study's findings put-forward that workforces with BCA are more satisfied with their careers. The finding of this study shows

that boundaryless careerists change their direction of career in-line with their own standard and desire for accomplishing increased career success. This research study's researcher agrees this research finding with the findings of one previous research study, which shows the significant effect between BCA and career success. Accepting the first hypothesis, it is viewed that the BCA in literature will show significant (and also positive) impact on career success has been supported empirically in this research study.

**Objective FOUR: To identify how the attributes of boundaryless career attitudes contributes to career success**

**Table 05**. Regression Results of Attributes of Boundaryless Career Attitudes and Career Success.

| | **Regression Analysis Results** | **As per information obtained through regression analysis, model of simple linear is expressed as:** |
|---|---|---|
| 1. Boundaryless Mindset and Career Success | ß=0.573, *p*=0.002 | $CS=1.695+0.573BM+\varepsilon$ |
| 2. Organizational Mobility Preference and Career Success | ß=0.518, *p*=0.002 | $CS=1.902+0.518OMP+\varepsilon$ |

As per the researcher's findings there is a positive impact between boundaryless mindset and careers success. This finding is consistent with the findings of previous researches, which state a positive impact between variables. Further, this study found that there's a significant impact between organizational mobility preference and career success. This finding is in consistent with findings of a research conducted in 2011 but contradictory with a research conducted in 2019 as it states that OMP is less significant. BM's positive impact and OMP's significant impact with career success can also be agreed with previous findings. With this study's positive and significant impact between BM and OMP with career success, it can be stated that the research has produced fresh and upgraded insight to literature of BCA.

**Table 06**. Hypothesis Summary.

| **Hypothesis** | | **Regression Results** | **Status** |
|---|---|---|---|
| **H1** | There is a significant impact of boundaryless career attitudes on career success. | ß=0.287, *p*=0.013 | Accepted |
| **H2** | There is a positive impact of boundaryless mindset on career success. | ß=0.573, *p*=0.002 | Accepted |
| **H3** | There is a significant impact of organizational mobility preference on career success. | ß=0.518, *p*=0.002 | Accepted |

## 4. Conclusions

This study's objectives were achieved using quantitative method. This research study's results reveal that boundaryless career attitude is important in predicting career success. It can be concluded stating that as per this study career attitude (BCA) greatly impact career success in the form of career satisfaction and boundaryless career attitude individuals are more likely to achieve career satisfaction. Especially, career attitude plays vital role in business consultant's career success.

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# STUDY OF INFLUENTIAL FACTORS AND THEIR IMPACT ON CONSUMER BEHAVIOR OF SKINCARE PRODUCTS: SPA CEYLON CUSTOMERS

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## Abstract

This research paper presents a comprehensive investigation into the consumer behavior patterns in the rapidly evolving skincare product industry. The study aims to gain a deep understanding of consumers' motivations, preferences, and decision-making processes when purchasing skincare products and provide justified conclusions and recommendations. The research identifies various factors influencing consumers' purchase decisions, including personal, social, economic and product factors. The research methodology involves a mono method under quantitative research by employing surveys using google forms distributed to a diverse sample of 238 skincare consumers of Spa Ceylon.

**Keywords:** Consumer behavior, Economic crisis, Product Factors, Social Factors

## Extended Abstract

### 1. Introduction

Consumer behavior research is crucial since it allows marketers to identify what drives customers' purchase decisions. Understanding how clients choose a product allows them to fill a market gap as well as assess what elements are essential and which are meaningless. Understanding consumer buying behaviors is the key to reaching out to and engaging consumers, as well as persuading them to purchase from the business (John, 2020). Skin care is an incomplete topic, it is a catch-all phrase for cleaning, perfuming, altering look, changing body odor, protecting, and maintaining "good condition" skin (Surber & Kottner, 2017). Consumers of all ages are continually looking for the "best" skincare products in their quest for flawless skin. Consumers face a decision dilemma whether they purchase at pharmacy shops, department stores, or online. They seek independent advice from friends, physicians, or favorite bloggers, frequently purchasing pricey goods that fail to live up to their claimed advantages (Rodan et al., 2016). Customers believe that purchasing skin care products is a requirement that they must fulfil in order to meet the nutritional demands of their face skin. This buying incentive is also the most powerful of the other motives (Faza et al., 2022).

### 2. Methodology

In positivism, creating hypotheses to test throughout the research process frequently entails using already-existing theory. Therefore, positivism research is used due to the 4 hypotheses created in this study that will be tested with the existing theory used in other academic studies. The deductive approach will be applied in this study due to the author’s use of formulating hypotheses and testing them out. Therefore, as mentioned above, the deductive method is a theory, and to test it, research strategies are designed as well as hypotheses that are produced. As a result, it was stated that the philosophy of positivism is primarily responsible

for deductive approach in research as a logical method (Karen 2010). Mono method is chosen for this study as this study is more focused on sending out the questionnaires to the consumers of Spa Ceylon as the topic is based on consumer behavior. In order to evaluate the data achieved of 350 respondents in a precise way it would be best suitable to use one method solely as it would be structured and easier to process the mass quantity of data by the author for data analysis. In this study, the research will be done based on survey. Therefore, it can be justified that a survey is a reliable approach to correctly represent a population while collecting information from a sizable number of respondents. Due to the quantitative method chosen for this study, a questionnaire will mean a survey to be conducted therefore, survey will enable the researcher to grasp a larger set of groups that will ensure a reliable and more valid set of responses to be analyzed. Cross-sectional time horizon will be employed in this study as a result of the above discussion. Due to the temporal constraints of this study, cross sectional data will be used to compare various demographic groups and elements at a certain point within the given time frame. Primary data collection will be utilized for this research therefore questionnaires will be the major tool. This makes the data produced from the study more trustworthy and valid than data obtained from other sources. The need for primary data collection is justified as this research studies about consumer behavior towards skincare products of Spa Ceylon, hence no other research or data has been provided for this topic, the author finds the need to collect first-hand information to address the research. Based on this research methodology, SPSS analysis tool will be employed by the author to analyze the collected data of 350 respondents. This would make analyzing more accurate and understandable for the author to reach the research objective of providing justified conclusions and recommendations for Spa Ceylon.

## 3. Results and Discussion

**Table 01**. Regression analysis figures showing the influence of independent variables while investigating the relationship between one independent variable and the dependent variable.

| Variable | T Value | Sig. Value |
|---|---|---|
| Personal Factors | 5.318 | .000 |
| Social Factors | 1.403 | .162 |
| Economic Factors | 1.739 | .083 |
| Product Factors | 9.985 | .000 |

The literature highlights that personal factor is a significant factor, with younger individuals (22-26) showing greater interest in skincare products, while some older individuals (31-40) may be less interested (Junaid & Nasreen, 2012; Salo, 2014). This is evident as many consumers who willingly participated in the survey were shown to be students accounting for 35.29%. Stages of the life cycle, such as education and marital status, are found to affect purchasing patterns (Sabharwal et al., 2014). Survey participation of 30.25% employed individuals account for the literature findings of employment and occupation playing a role in skincare, with career-oriented women prioritizing appearance (Qazzafi, 2020; Liu, 2006, cited in Sabharwal et al., 2014). The correlation and regression analyses in the findings quantitatively support the literature's qualitative observations about the relationship between personal factors and consumer behavior as the correlation analysis indicates a moderate relationship (Pearson correlation coefficient of 0.617) between personal factors and consumer behavior, with a strong significance level (Sig. 0.000) and the regression analysis further supports the significance of personal factors, as indicated by a highly significant Sig. value of 0.000 meaning that personal attributes like age,

stages of life cycle and personality significantly impact how customers respond to Spa Ceylon products and services.

The findings of the literature study on the impact of social factors on consumer behavior show that religious views might influence the purchasing process, implying that religious boundaries may affect consumer behavior (Hawkins et al., 1980, quoted in Nasar et al., 2012). In the domain of skincare goods, religious exclusivism and religious retribution are also thought to impact customer behavior (Agarwala et al., 2019). Individuals use skincare products to fit with urban fashion trends and show their self-concept, according to the literature (Junaid & Nasreen, 2012; Dewi, 2022). The correlation study shows a strong positive association (Pearson correlation coefficient of 0.499) between social factors and consumer behavior, with a significant degree of significance (Sig. 0.000). However, the regression analysis suggests that social factors, as measured in the study, are not statistically significant at the conventional significance level of 0.05 (Sig. 0.162) causing the hypothesis to be rejected to make a conclusion as the strength of the relationship between social factors and consumer behavior in the context of skincare product choices to be null.

The review literature investigates the impact of economic factors, including personal income, post-COVID-19 effects, and economic crises, on consumer behavior in the skincare businesses. It emphasizes the link between household income and cosmetics expenditure, with higher-income individuals dedicating a larger portion of their budget to cosmetic purchases (Sabharwal et al., 2014). The post-COVID-19 influence on skincare product knowledge and consumption is also discussed in the literature, with consumers turning to skincare as a form of self-care and hygiene (Choi et al., 2022; Gardner, 2021). Economic downturns have been identified as potential drivers of lower expenditure on luxury items and skincare products (Jiachen, 2022; Boonmangmee and Methavasaraphak, 2021). The correlation analysis indicates a moderate positive relationship (Pearson correlation coefficient of 0.500) between economic factors and consumer behavior, with a strong significance level (Sig. 0.000). However, it can be stated that economic factors do not affect consumer buying behavior towards skincare as the regression analysis suggests that economic factors, as measured in the study, do not play a highly significant role in shaping consumer behavior (Sig. 0.083).

The literature review explores various product factors, such as brand image, brand trust/value, brand awareness, price, and product quality/features/design, and their impact on consumer behavior in the skincare industry. It emphasizes the importance of brand image, implying that consumers frequently buy not just a product but also the image connected with it (Sudaryanto et al., 2020; Evans et al., 2006). Consumer behavior is influenced by brand trust and perceived value (Suvattanadilok, 2020; Huda & Sultan, 2013). In addition, the literature highlights the significance of brand awareness in influencing customer decisions (Schmidt and Eisend, 2015). Price is seen as an important factor, although its importance varies across customers (Kim, Xu, and Gupta, 2012, cited in Suvattanadilok, 2020; Sabharwal et al., 2014). Product quality, features, and design have been identified as important factors of customer decisions, particularly during economic downturns (Boonmangmee, Methavasaraphak, 2021; Kircher and Postlewaite, 2008, quoted in Suvattanadilok, 2020). The correlation analysis in the findings indicates a strong positive relationship (Pearson correlation coefficient of 0.680) between product factors and consumer behavior, supporting the significance of these factors (Sig. 0.000) along with the regression analysis further emphasizing the importance of product factors (Sig. 0.000), indicating that features, quality, branding, and other product-related aspects significantly influence consumer behavior.

**Table 02**. Summary of Hypothesis

| Hypothesis | Accepted | Rejected |
|---|---|---|
| There is a relationship between personal factors and consumer behavior. | ✓ | |
| There is a relationship between social factors and consumer behavior. | | ✓ |
| There is a relationship between economic factors and consumer behavior. | | ✓ |
| There is a relationship between product factors and consumer behavior. | ✓ | |

## 4. Conclusions

As per the review of literature it can be derived that the consumer behavior of Spa Ceylon customers towards purchases has not been changed during or after the economic crisis. Personal factors such as employment, stages of life cycle, personality has affected consumer behavior throughout their purchase period, this might mean that consumers have had gradual shifts in their consumptions of these products with timely changes in their life structures. It would also mean that consumers most likely consume these purchases due to their personal attributes in life. Furthermore, these consumer response pattern has also shown much more connection with product factors meaning that all their purchases are dependent and consistent due to the product related attributes of quality, value, features, design, awareness, brand image and price of Spa Ceylon products. On the contrary, consumers have neglected the social perspective of life as seen from the analysis as factors relating to religion, cultures or social status having no effect on consumer behavior. This would possibly mean that the sample population of Gen Y and Gen Z have neglected and move past societal restraints to a much more individual liberty, also showing that purchasing a “luxury product” has no intention of conveying an indirect idea to others. Additionally, the economic factor has also been considered to have no affect based on the study, this means that the consumers’ desire and purchase motive to consume skincare during an economic crisis or pandemic remains unchanged, showing that skincare is almost as equal to a necessity in life. It also conveys that consumers purchasing Spa Ceylon products have much of a stable income while compared to others due to their buying patterns. So, as a whole, it can be concluded that consumers of Spa Ceylon products purchase based on their personal life structures and determine their purchases mainly on how the product meets to satisfy the stated value up to the required standard as conveyed.

To help Spa Ceylon improve and retain consumer behavior towards their products, it's essential to focus on various aspects of the customer experience. Consumer behavior can be improved and retained through the following practices:

The operations managers should ensure that the quality of Spa Ceylon products remains consistently high by regularly reviewing and improving formulations to meet customer expectations. They can also conduct quality control checks at different stages of production to maintain consistency. As a result, high-quality products would lead to greater customer satisfaction and loyalty, which is essential for long-term success.

The marketing managers can create content and campaigns that educate consumers about the benefits of Spa Ceylon products, their ingredients, and how to use them effectively. They could also highlight the unique selling points of the products, such as natural ingredients, ethical sourcing, or cultural inspirations to create a unique perspective and competence in the

consumers' mind. Emphasizing unique aspects of the brand would help Spa Ceylon stand out in the crowded skincare market in Sri Lanka. This approach would also be much more effective as the study identified the relationship between product factors and consumer behavior.

The research and development team could leverage customer data to offer personalized products or recommendations and special offers to suit their needs. This would make consumers much more satisfied with the product and it's value. They can also use AI and data analytics tools to understand customer behavior and tailor productive marketing efforts accordingly. Personalized offerings would show that Spa Ceylon values its customers and their requirements. Studying consumer data would also help Spa Ceylon to secure it's brand position by continuingly being in line with evolving consumer behavior trends and needs.

The sales team could offer flexible pricing options, such as installment payment options without capping a limit or sample packs at lower price points. This allows consumers to continue experiencing the products without a significant financial burden in a manageable manner. They could also implement strategic discounts and promotions, particularly during shopping seasons like holidays, also they could build strategic partnerships with other businesses where purchases would be related for exclusive discounts.

Spa Ceylon could also follow a diversification strategy to spread the risk of operations, they could consider makeup products to target a significant number of consumers in the Sri Lankan market. This plan would also have a much probability of success as Spa Ceylon has been capable of maintaining a strong brand image about the value the products hold, potentially increasing revenue by reaching and retaining the vast consumer base.

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# INVESTIGATING THE IMPACT OF SERVICE QUALITY ON CUSTOMER SATISFACTION AT "ABC BANK PLC"

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## Abstract

Customer satisfaction is a key factor over all organization as it helps the organization to achieve organization goals and objectives easily. The retention and the sustainability of an organization fully depends on customer satisfaction. Impacting level of customer satisfaction can be measured by many metrics but in this research the researcher has used main five dimensions of service quality such as, empathy, responsiveness, reliability, tangibility and assurance. Based on these five dimensions of service quality the level of impacting will be reflecting the relationship between customer satisfaction and the dimension factors. The main purpose of the study is also to test the hypothesis or the relationship between them. The research analyzed and conducted on ABC Bank Plc sri lanka. By covering only Colombo district data will be collected through survey questionnaire method and it will be collected from nearly 350 respondents as the research method used is quantitative.

Key words: - Customer satisfaction, service quality, empathy, responsiveness, tangibility, reliability, assurance, Quantitative research method, qualitative research method, research onion.

## Extended Abstract

### 1. Introduction

Background of the study is that banks must meet the needs of their customers in order to achieve sustainable development (Milklos, et al. ,2019). The aim of this paper is to investigating service quality dimensions which can be used to measure customer satisfaction, and the effect of these dimensions (tangibles, responsiveness, empathy, assurance, reliability, access) on customer satisfaction in ABC Bank Plc in sri lanka. Lassar, Manolis and Winsor (2000) has stated that service quality is commonly noted as a critical requirement for establishing and sustaining satisfying relationships with valued customers.

The research problem is that in 2020 when sri lanka was affected by covid 19 pandemic, the customers quickly moving towards other alternative banks as, a result customer satisfaction began to decline compared to before. Then again along with that when the economic crisis arose

in 2021 beginning of the year customer satisfaction has gone more down which was mentioned by employees and managers of the bank.

These are the research objectives. Investigating the impact of service quality on customer satisfaction at ABC Bank Plc, Identifying the impact of reliability on customer satisfaction at ABC Bank Plc, Identifying the impact of responsiveness on customer satisfaction at ABC Bank Plc, Investigating the impact of assurance on customer satisfaction at ABC Bank Plc, Examining the impact of empathy on customer satisfaction at ABC Bank Plc and Examining the impact of tangibility on customer satisfaction at ABC Bank Plc.

The significance of the studies are according to Slack, Singh and Sharma (2019) research has conducted on supermarket service and zygaris, Hameed, Alsubaie and Rehman (2012) conducted research on auto mobile industry. But this research is done on banking industry`s one selective bank. The selected bank is ABC Bank Plc and since it is the only Islamic bank allocated in Sri lanka the research will benefit the future Islamic banks establishment in the country. Rehman (2012) further declare that service quality is an important dimension for customer satisfaction and by maintaining service quality, competitive advantage can be gained which will lead to long term relationship with customers in Islamic banks and similarly ABC Bank Plc can gain it by this research.

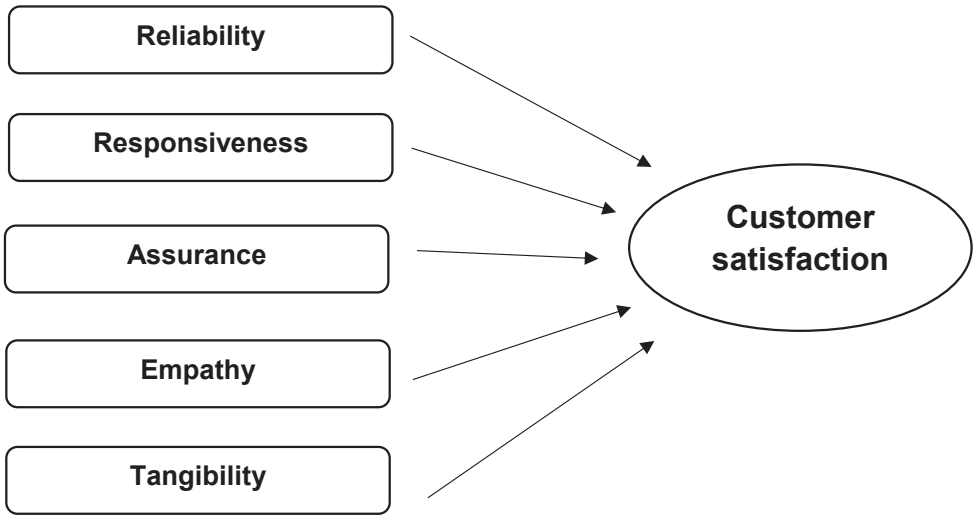
The scope and limitations are given under this paragraph. The research mentioned aims to analyze the impact of five quality dimensions on customer satisfaction specifically at ABC Bank. The study will focus on the relationship between each factor of these dimensions separately. It is important to note that the research will only collect responses from customers in the Colombo district, targeting approximately 350 randomly selected participants. While previous studies conducted by Rehman (2012), Khashman (2023), and Janahi, Almubarak (2017) have explored the banking industry as a whole, this research is limited to the behavior of one specific organization, ABC Bank. Therefore, the findings of this research will be specific to ABC Bank and may not be generalized to the entire banking industry. Additionally, it is worth mentioning that Slack, Singh, and Sharma (2019) conducted a research study in a different industry, specifically focusing on 480 supermarket customers. In contrast, this research will solely focus on 350 customers of ABC Bank Plc.

## 2. Methodology

This study investigated the customer satisfaction regarding the service quality of the ABC Bank Plc, in Sri Lanka. Quantitative methodology and Questionnaire technique is used to collect the data on service quality on the customers of Islamic bank which is ABC Bank Plc. The sample plans

to consist of 350 respondents focusing only Colombo district customers. The survey questionnaire will be filled by sending questionnaire through e-mail and online link was created which allowed the respondents to answer to the questions asked in the survey. The sampling method was random and snowball method.

**Conceptual Framework**




**Hypotheses**

- H1: There is a relationship between impact of Reliability and Customer satisfaction
- H2: There is a relationship between impact of Responsiveness and Customer satisfaction
- H3: There is a relationship between impact of Assurance and Customer satisfaction
- H4: There is a relationship between impact of Empathy and Customer satisfaction
- H5: There is a relationship between impact of Tangibility and Customer satisfaction

## Results and Discussion

**Demographic data analysis: -**

Considering responses gender most of them were female responses which stands for 51.43%. Also, age wise majority of the responses were collected from 19-30 age gap which stands for 43.43%. Next, considering the types of accounts used at ABC Bank Plc responses reflects “Savings account” is the most used account in the bank which stands for 49.71%. Lastly, when

it comes to the years of experiences of the responses, majority of them has 1-3 years of experience with the bank which stands for 38.29%.

**Inferential Analysis: -**

**Table 1*:* -** Correlation of Customers satisfaction & Independent Variables

| | Customer Satisfaction | |
|---|---|---|
| **Independent Variables** | **Sig Value** | **Pearson Correlation** |
| **Reliability** | <.0.01 | .826** |
| **Responsiveness** | <.0.01 | .806** |
| **Assurance** | <.0.01 | .786** |
| **Empathy** | <.0.01 | .824** |
| **Tangibility** | <.0.01 | .818** |

**Table 2: -** Regression of Customer Satisfaction & independent variables

**Coefficients**

| Model | | Unstandardized Coefficients | | Standardized Coefficients | | | Hypothesis |
|---|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | t | Sig. | |
| 1 | **(Constant)** | .061 | .086 | | .709 | .479 | |
| | **Reliability** | .264 | .058 | .252 | 4.551 | .000 | **Accepted** |
| | **Responsiveness** | .146 | .057 | .139 | 2.549 | .011 | **Accepted** |
| | **Assurance** | .131 | .049 | .133 | 2.666 | .008 | **Accepted** |
| | **Empathy** | .180 | .058 | .184 | 3.117 | .002 | **Accepted** |
| | **Tangibility** | .234 | .050 | .245 | 4.704 | .000 | **Accepted** |

Dependent Variable: Customer Satisfaction

According to the correlation and regression tables results of the research, both ensures that all the independent variables which are, reliability, responsiveness, assurance, empathy and tangibility`s and dependent variable which is Customer satisfaction`s sig value were below 0.05 and Pearson correlation value were above 0.75. Which reflected that there is a strong significant positive relationship as well as all the hypothesis were accepted.

## 3. Conclusions

**Demographic data: -**

The demographic data analysis reveals that the majority of respondents were females, which could be attributed to the fact that in the Colombo district, many females are employed and may find it convenient to use ABC Bank Plc due to the availability of requested gender employees. The age group of 19-30 showed the highest response rate, indicating that young and middle-aged individuals who are engaged in businesses, jobs, and other activities have a greater need for

banking services. On the other hand, the age groups above 51 and below 18 had the lowest response rate, possibly due to a lack of awareness or difficulties in accessing services from ABC Bank Plc. Most customers reported having savings accounts rather than fixed deposit or current accounts, suggesting a lack of awareness about the benefits and policies associated with these account types. Lastly, the majority of respondents had been using banking services for 1-3 years, indicating that the bank has attracted a significant customer base in recent years, while the number of customers with less than 1 year of experience was relatively low.

**Objective achievement of the research: -**

All the objectives were achieved as the results gave a proper answer and understanding on investing the impact of independent variables and dependent variable of the study and the hypothesis were accepted. Also, this was supported by the research`s literature review which mentions there is an impact on each variable on customer satisfaction at banks. The reason for service quality and customer satisfaction having a significant impact is that because the researcher used SERVEQUAL model which contains five categories, namely: reliability, responsiveness, assurance, empathy and tangibility and since if customers of the bank feels easy to use banks account, gets a good employee interaction which lead them to recommend the bank to others as well. This was supported by Sarifuddin, (2015) and Miklos, et al., (2019) `s research mentioned in this research literature review.

Next impact of reliability on customer satisfaction at ABC Bank Plc, ensured a positive relationship as customers at ABC Bank Plc are able to get access to their past accounts, customers get timely notified and alert regarding new updates and their transactions are being done in less- time at the bank. Also, usually in sri lankan context a bank cannot sustain if the reliability factors are lacking it is possible that this result is accurate. As per literature, Miklos, Nagay, Haddad and popp (2019) and Khashman (2021) `s research gave the similar finding. The impact of responsiveness on customer satisfaction at ABC Bank Plc reflected that there is a significant impact and the reason since sri Lankan’s are very sensitive towards others responses, ABC Bank Plc has a proper responsive system and gains trust of the customers in Colombo district context might be causing this positive impact towards both the variables. This was supported by literature as Fida, Ahamed, Al-Balushi and Singh (2020) and Khashman (2021) `s research by mentioning there is a significant impact. Next, impact of assurance on customer satisfaction at ABC Bank Plc reflected as there is a significant impact and it can be because customers believe that their personal information is safe guarded with ABC Bank Plc`s privacy policy, customers gets relevant responses regarding disputes and bank service is done according to relevant regulators and compliances of Sri Lanka. Literature supports as, Vu (2021), Rehman, (2012) and Khashman, (2021) `s research the similar finding.

Next, impact of empathy on customer satisfaction at ABC Bank Plc was found as there is a significant impact and it can be because ABC Bank Plc customers are receiving immediate complain resolutions, their banking process are transparent and the customers are getting personalized customer service, advice and other facilities from the employees at ABC bank. As, per literature, Jahani and Almubarak, (2017), Ahmad and papstathopoulos (2018) and Lomendra, et al., (2019) ` s findings support this research findings. Lastly, the impact of tangibility on customer satisfaction at ABC Bank Plc also reflected as there is a significant relationship since because there is considerable amount of ATM machines are facilitated and visible in Colombo district, Customers at ABC Bank Plc get to experience many accessibility facilities and features at the bank (e.g.: - facilities for disabled people) and ABC Bank Plc`s branch appearance, interior designs and other digitalized facilities are in good state.

Also, the research concludes by indicating that even though service quality is impacting ABC Bank Plc`s customer satisfaction, according to the problem identification service quality dimensions are not the cause for customer satisfaction reduction at the bank.

**Recommendations: -**

**For the bank-**

To improve service quality and attract more customers, ABC Bank Plc should prioritize areas directly related to customer service, such as tellers, ATM operations, transaction speed, convenient operating hours, and a variety of financial products. Increasing knowledge and awareness about Islamic banking is crucial since ABC Bank Plc is the only Islamic bank in Sri Lanka. Conducting seminars and other educational initiatives can help spread awareness about Islamic banking and its unique features. Reliability is a significant factor in customer satisfaction, so effective communication, smooth transactions, consistent quality, and employee training should be ensured. Additionally, ABC Bank Plc should focus on catering to the needs of older and below 18 customers by providing separate trained employees and flexible online banking options. Improving the design and content of the bank's website can also enhance the online banking experience for both existing and potential customers.

**For the study-**

First, since this research was only targeting Colombo district customer base was a major limitation of this study. So, by Expand the research beyond the Colombo district to include different regions or even nationwide. Second, in the future even if these methods are used it can be improved by using stratified sampling method (Divide the population into separate subgroups (strata) and then randomly sample within each subgroup) and Cluster sampling method (Dividing the population into clusters based on geographical or organizational and randomly select a few clusters for data

collection). Third, to investigate the service quality in any banks in future research the researchers can use CARTER model instead of SERVQUAL Model. As, per the literature Sarifuddin, (2015) and Rehman (2012) `s findings indicate that CARTER model is very popular in previous studies done on Islamic banks.

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# IMPACT OF BRAND AWARENESS ON CONSUMER PURCHASE INTENTION TOWARDS DSI FOOTWEAR IN MATALE DISTRICT

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## Abstract

Marketing assumes that customer is the king, who controls and influences the business. Today, the business environment is very complex than earlier. Different companies are producing different brands in similar product category. Therefore each and every person has lot of choices to fulfill their needs and wants. Therefore, this research study is carried out to evaluate the impact of brand awareness on consumer purchase intention towards DSI footwear in Matale district. Structured questionnaires were issued within the sample of 100 respondents yield good response rate, using convenience sampling method.

The conceptual framework and hypothesis were developed through careful review of literature and findings derived by using correlation and linear regression with version 20.0 of the Statistical Package for Social Science. The results revealed that top-of-mind was considered as the major predictor in determining consumer purchase intention of DSI footwear. So the objectives of the study were achieved and clearly explored the brand awareness highly impact on consumer purchase intention towards DSI footwear in Matale district. Therefore this research study provides direction to the marketers for their survival in the market place as well as to the consumers who always judge the product purchase with their own evaluation method.

***Key words:*** *Brand Awareness, Brand Recall, Brand Recognition, Consumer Purchase Intention, Top-of-mind.*

## 1. Introduction

"A brand is a name, term, symbol, design or combination of them which is intended to signify the goods and services of a seller or a group of sellers and to differentiate them from those of competitors"**(**American Marketing Association). A brand is seen as one of a company's most valuable assets. It represents the face of the company, the recognizable logo, slogan, or mark that the public associated with the company. Brand awareness is a marketing term that describes the degree of consumer recognition of a product by its name. Creating brand awareness is key step in promoting a new product or reviving an older brand. Ideally,

awareness of the brand may include the qualities that distinguish the product from its competition.

Purchase intention on the other hand is the situation when a customer repeatedly purchases the same product over a period of time-based on their initial purchase. It is vital that companies hold on to these customers since they are the most profitable as well, they are those that provide free marketing by positive word of mouth. Engel *et al.* (1995) divides the purchase intention into "**Unplanned buying, Partially - Planned buying and Fully Planned buying**". Consumers sometimes buy on their gut feelings and the decision is made at the store. This type of decision can be categorized into an unplanned buying decision. Partially-planned buying means that consumers decide the product category before going to the store, and decides about the brand after arriving at the store. Then comes the fully planned buying decision, it means the consumer decides about the product and the brand before entering the store.

## 2. Methodology

This research examines that the impact of brand awareness on buyers purchase intention towards DSI in Matale district. The quantitative method will be used in this study. . Population of this study consists of buyers of DSI in Matale divisional secretariat division. Presently, DSI has over 200 showrooms in Island wide. In Matale area there are 3 DSI showrooms. The data will be collected from 100 customers who are buying DSI footwear. In ordered to collect the data simple random sampling will be used.

In this study primary data collection method will be used. For that closed ended questionnaire will be distributed by the researcher to collect the data. Statistical Package for Social Science (SPSS Version) will be used to present the data about respondents profile by conducting descriptive analysis. Under the inferential analysis, linear regression analysis will be carried out to find out the impact of brand awareness on buyers purchase intention toward DSI in Matale district.

### 3.2 Correlation Analysis

In the bellow table 3.2, shows there is significant relationship between brand awareness (brand recognition, brand recall, top-of-mind) and consumer purchase intention towards DSI footwear. The significant value is 0.000 for all three variables. The Pearson correlation value shows that, there is a positive relationship between the variables. Brand recognition, brand recall and top

of mind variables are positively correlated with consumer purchase intention with the correlation values 0.611, 0.792 and 0.796 respectively. Brand awareness and consumer purchase intention have strong positive correlation (r=0.821).

**Table 03.2:** Correlation results of brand awareness (brand recognition, brand recall, top-of-mind) and consumer purchase intention.

| | | Consumer Purchase Intention | Brand Awareness | Brand Recognition | Brand Recall | Top-of-Mind |
|---|---|---|---|---|---|---|
| CPI | Pearson Correlation | 1 | .821** | .611** | .792** | .796** |
| | Sig. (2-tailed) | | .000 | .000 | .000 | .000 |
| | N | 100 | 100 | 100 | 100 | 100 |
| BA | Pearson Correlation | .821** | 1 | .867** | .924** | .892** |
| | Sig. (2-tailed) | .000 | | .000 | .000 | .000 |
| | N | 100 | 100 | 100 | 100 | 100 |
| BR | Pearson Correlation | .611** | .867** | 1 | .712** | .623** |
| | Sig. (2-tailed) | .000 | .000 | | .000 | .000 |
| | N | 100 | 100 | 100 | 100 | 100 |
| BC | Pearson Correlation | .792** | .924** | .712** | 1 | .764** |
| | Sig. (2-tailed) | .000 | .000 | .000 | | .000 |
| | N | 100 | 100 | 100 | 100 | 100 |
| TM | Pearson Correlation | .796** | .892** | .623** | .764** | 1 |
| | Sig. (2-tailed) | .000 | .000 | .000 | .000 | |
| | N | 100 | 100 | 100 | 100 | 100 |

**. Correlation is significant at the 0.01 level (2-tailed).

CPI=Consumer Purchase Intention; BA=Brand Awareness; BR=Brand Recognition; BC=Brand Recall; TM=Top-of-Mind

***Source:*** *Survey Data (2021)*

### 3.3 Regression Analysis

**3.4 Table 03.3:** Regression analysis on brand awareness and consumer purchase intention

| Dependent Variable | Independent Variable | R | R Square | Adjusted R Square | F Value | Beta Value | Sig. |
|---|---|---|---|---|---|---|---|
| Consumer Purchase Intention | (constant) | .821[a] | .674 | .671 | 202.67 | .436 | .088 |
| | Brand Awareness | | | | | .892 | .000 |

Note: a. Predictors: (Constant), Brand Awareness: CPI= Consumer Purchase Intention; BA= Brand Awareness

***Source:*** *Survey Data (2021)*

The above Table 4.6 shows that adjusted R square is 0.671 which mean brand awareness is able to explain 67% of variance in consumer purchase intention. A significant simple linear regression equation was found F=202.67, P<0.05. Brand awareness has significantly positive impact on consumer purchase intention. Therefore, Hypothesis $H_1$ is accepted.

### 3.5 Multiple Linear Regression Analysis

**Table 03.4**: Regression analysis for impact of brand awareness on consumer purchase intention

**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .846[a] | .715 | .706 | .445 |

a. Predictors: (Constant), Top-of-Mind, Brand Recognition, Brand Recall

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 47.806 | 3 | 15.935 | 80.408 | .000[b] |
| | Residual | 19.025 | 96 | .198 | | |
| | Total | 66.832 | 99 | | | |

a. Dependent Variable: Consumer Purchase Intention

b. Predictors: (Constant), Top-of-Mind, Brand Recognition, Brand Recall

**Coefficients**

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | .475 | .239 | | 1.989 | .050 |
| | Brand Recognition | .322 | .078 | .322 | 4.282 | .009 |
| | Brand Recall | .411 | .092 | .428 | 4.481 | .000 |
| | Top-of-Mind | .438 | .082 | .456 | 5.322 | .000 |

a. Dependent Variable: Consumer Purchase Intention

***Source:*** *Survey Data (2021)*

The model fit can be evaluated by using the value of adjusted R square. In this table this value is 0.706 which means 70.6% of variance on consumer purchase intention explained by brand recognition, brand recall and top-of-mind. Rest of 30% variance on consumer purchase intention is explained by other factors.

Based on the standardized coefficient beta can estimate the relation contribution of each independent variable. According to the above table top-of-mind has the value 0.438 shows that higher percentage of contribution nearly 43.8% given by the top-of-mind to the consumer purchase intention. Brand recall has the value 0.411 shows that next higher contribution nearly 41.1% given by the brand recall to the consumer purchase intention. Brand recognition has the value 0.322 shows that lower contribution nearly 32.2% given by the brand recognition to the consumer purchase intention.

**Table 03.5:** Hypotheses Testing with Results

| Hypotheses | Beta | Adjusted $R^2$ | Sig. | Result |
|---|---|---|---|---|
| **$H_1$:** There is a significant impact of brand awareness on consumer purchase intention towards DSI footwear in Matale district. | 0.892 | 0.671 | 0.000 | Accepted |

| | | | | |
|---|---|---|---|---|
| **$H_a$:** There is a significant impact of brand recognition on consumer purchase intention towards DSI footwear in Matale district. | 0.608 | 0.367 | 0.000 | Accepted |
| **$H_b$:** There is a significant impact of brand recall on consumer purchase intention towards DSI footwear in Matale district. | 0.760 | 0.627 | 0.000 | Accepted |
| **$H_c$:** There is a significant impact of top of mind on consumer purchase intention towards DSI footwear in Matale district. | 0.765 | 0.631 | 0.000 | Accepted |

***Source:*** *Survey Data (2021)*

As this research is carried out to evaluate the impact of brand awareness (brand recognition, brand recall, top-of-mind) on consumer purchase intention towards DSI footwear in Matale district. The result obtained from the study is in line with the researches done in the past.

The hypotheses were developed to identify impact of brand recognition, brand recall and top-of-mind that have proved from $H_a$ to $H_c$ are significantly positive impact on consumer purchase intention. Therefore, all above objectives and hypotheses are achieved and accepted. Based on the simple linear regression results, top-of-mind has to be considered as major predictor of determining consumer purchase intention as it highest impact on consumer purchase intention by 76.5%. As well as brand recall are contributed as second largest variable to create consumer purchase intention by 76%.

Shahid et al., (2007) stated that according to brand awareness plays a vital positive role on consumer purchase intention. Through this research it can be identified that, there is a high consumer purchase intention of DSI footwear because of brand awareness. In other words, there should be brand awareness in the consumer's mind in order for a purchase intention to occur.

Moreover, all the variables have strong positive correlations with consumer purchase intention. These are the major findings of the research that the researcher was evaluated. Finally, from

this study, researcher can come up with the conclusions as the variables brand recognition, brand recall, top-of-mind have high impact on consumer purchase intention of DSI consumers in Matale district.

## 3. Conclusions

This research was able to prove that there is a relationship between brand awareness and consumer purchase intention and the fact that consumer purchase intention depends on brand awareness. These are the major finding of the research that researcher was evaluated. Therefore, in conclusion it can be stated that having a base of consumers that is aware of a company it's products, that it will be an immense boost to the overall company's current profits and eventual definite future sales. Finally, from this study, researcher can come up with the conclusion as the brand awareness can affect on consumer purchase intention in DSI footwear.

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# ANALYSIS OF FACTORS AFFECTING BUDGETARY CONTROLS (IN THE CONTEXT OF AMS HEALTHCARE SECTOR)

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## Extended Abstract

### Abstract

This study examines the factors (accounting information systems, role of other functional departments, structure of the organization and environmental uncertainties) that affects budgetary control in the context of healthcare sector of AMS holdings. The research problem is continuous negative contradiction between budgets and actual results. And the solution is recommended based on the to research findings with regards to the business recovery concept. Quantitative methodology was used to conduct, by using survey questionnaire for data collection, targeting a random sample of 76 respondents.

Keywords: Budgetary control, accounting information systems, other departments, organizational structure and environmental uncertainties.

## 1. Introduction

Budgets are more than just an instrument that helps management to plan and control (Cohen and Karatzimas, 2011). Budgetary control is the process of comparing and contrasting the actual cash flow with forecasted cash flow in order to make required decisions (Cohen and Karatzimas, 2011; Mohamed et al., 2016). Due to lack of clear analysis in relation to the chosen factors “accounting information systems, impacts of other departments, organization structure and external uncertainties”, this research was required. AMS holdings is a group of company trading in different industries and healthcare is one. The laboratory services also falls under this sector. There are separate functional departments operating for their healthcare sector. The problem statement is that the budgets and the actual results are contradicting since last year. The sudden change of inflation from 1 digit to 2 digit during 2022 created the initial fail in budgetary control of AMS. Eventually, they faced difficulties in making appropriate assumptions and forecasts of the costs and revenue. The failure of the newly opened lab clearly portraits this issue. Because they

budgeted a certain revenue and expenditure expecting for a good profit but they ended up in a loss. Then they created a forecast to outsource the activities to cut down certain costs and still it was a failure. If this continues eventually AMS will be performing below their capacity, hence this needs a business recovery solution. This research was conducted to gain an in-depth knowledge and suggest a realistic business recovery solution.

**Research questions:**

- How does accounting information systems affect budgetary control?
- What are impacts of other departments on budgetary control?
- How does organization structure influence budgetary control?
- Why environmental uncertainties does has an impact on budgetary control?
- What kind of solution would realistically address the issue?

Pervious researches mostly has covered the influence of budget, budgetary control or budgetary slack on an organization, whereas this research has explained the influences of several other factors upon budgetary control. The previous research data related to environmental uncertainty were drawn from firms in the Sydney, Australia, and metropolitan area, hence the results are most suitable only for that population (Dunk, 1995). This research will majorly benefit the management accountants of AMS and other similar organizations. Apart from the significances the main limitation of this study is that most of the influencing factors are internal factors while only one is considered in the external context and this study is limited by assumptions made based on only 76 respondent's covering only 4 departments (marketing, finance and human resources) representing the whole organization, which might question the accuracy.

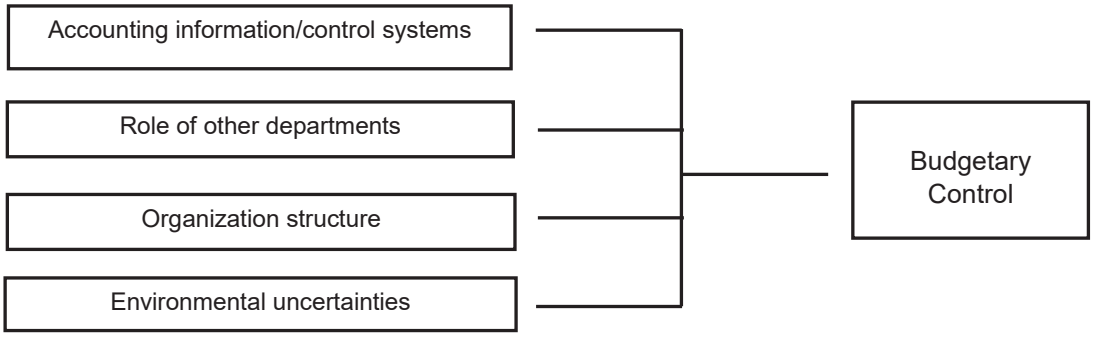
Budgets are financial forecasted plans which directs an organization toward the goals, acts as a performance evaluator, communicates future plans, motivates managers by targets, coordinates and controls organizational activities; Budgetary control is an important part of the management accounting (Ekholm and Wallin, 2000; Libby and Lindsay, 2010; Lu, 2011; Tsamenyi et al., 2004; Drury, 2021). Presence of accounting information value orientation will increase accounting performance and deliver efficient information (Bushee et al., 2010), which will also support the budgetary control. Accounting information reliability emphasis helps to predict the financial situations of the firms (Bukenya, 2014). Nevertheless, these systems are frequently vulnerable to security breaches, which can expose and misuse an organization's sensitive information (Al-Delawi, 2020). Mohamed and Ali (2013) suggested that budgeting systems have a significant positive relationship with corporate performance (of every department). Based on the available

researches (Cohen and Karatzimas, 2011), it is evidenced that HR management initiatives impact accounting aspects such as budget. In contrast, Cohen and Karatzimas, (2011) quotes “Our empirical evidence shows that the HR department does not play a key role during the budget procedures and, therefore, it does not exploit the full potentials offered by budgeting”. Libby and Lindsay (2010) also confronted a similar point. Substantial involvement of employees and middle managers in formulation of the budget, will improve communication, and ensure that more realistic information are accumulated during the budget process. Furthermore, such budget setting and budget variances analysis activities reduce information asymmetry (Emsley, 2001). Literature reveals that empirical research on marketing management practices in relation to budget are insignificant (Filiatrault and Chebat, 1987).

Hopwood (1974) stated that budgeting system and organizational structure & culture are inseparable and interdependent. Brune (1975) quoted “budgets are the financial plans those provide a basis for directing and evaluating the performance of individuals or segments of organizations”. Budgets, helps to coordinate and control function of different parts of an organization, which ensures the responsibilities delegated to managers throughout the organizational structure, via its measures and strategies. For instance, if a decentralized decision-making authority is in place, organization become more powerful segment wise, and in such case responsibility of managers for financial variables will be higher, and financial control systems will be more complex. On the other hand, organization structural changes as per requirement might be a way to enhance effectiveness of budgetary control (Bruns 1975). In contrast, as per the study of Gordon and Narayanan (1984) there is a minor importance only for organizational structure in management accounting (Budget is a part of management accounting) related decision-makers. Environmental uncertainties are the dynamic factors in the external environment that affects an organization (Kren, 2003). Ezzamel (1990) also stated that budgets and environmental uncertainty has a positive correlation. When the literature is reviewed it is found that researches have controversial results also on the relationship between budget and environmental uncertainties. Researchers (Govindarajan, 1984, 1988; Gul and Chia, 1994) argue that when environmental uncertainty is low predictions are more accurate, hence budget targets can be considered as a valid performance indicators only during low environmental uncertainty. Following that they also confronted that during high environmental uncertainty, budget information are less likely to portrait firm’s original position and performance. Therefore, literature reflects that when environmental uncertainty is low, budgetary controls are more reliable than when it is high.

## 2. Methodology

This research was conducted using the quantitative methodology, since the purpose of this research is to analyze the influence of few factors upon budgeting. A set of questionnaire were prepared in a survey form which is the most common quantitative research tool, and was shared among the sample within the organization to get the responses. SPSS software was used for data analysis, since the results won't be biases. This research sample was 76 employees from marketing, human resources, operations and finance departments under the AMS healthcare sector. Survey was conducted using snowball sampling method.




## 3. Results and Discussion

| Independent variables | | Budgetary control (dependent variable) |
|---|---|---|
| | P Value | Co-efficient |
| **Accounting information system** | 0.001 | 0.674 |
| **Role of other departments** | 0.001 | 0.488 |
| **Organizational structure** | 0.001 | 0.376 |
| **Environmental uncertainty** | 0.006 | -0.313 |

**Table 1:** Correlation analysis

Above correlation analysis table indicates that there is a significant correlation between budgetary control and all the independent variables since all the P values (0.001, 0.001, 001 & 0.006) are lower than the standard P value (0.05).

Pearson coefficient value of 0.674 indicates a positive strong relationship between “accounting information system” and “budgetary control” variables. Pearson coefficient value of 0.488 indicates a positive moderate relationship between “role of other department” and “budgetary control” variables. Pearson coefficient value of 0.376 indicates a positive moderate relationship between “organizational structure” and “budgetary control” variables. Pearson coefficient value of 0.616 indicates a negative relationship between “environmental uncertainty” and “budgetary control” variables.

Therefore, the analysis ultimately indicates a significant correlation between all independent variables and dependent variable.

| Model | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | |
|---|---|---|---|---|---|---|
| | B | Std. Error | Beta | | | Hypothesis |
| (Constant) | 1.756 | .506 | | 3.468 | <.001 | |
| Accounting information system | .695 | .135 | .659 | 5.134 | <.001 | Accepted |
| Role of other departments | .092 | .116 | .105 | .790 | .432 | Rejected |
| Organizational structure | -.088 | .141 | -.105 | -.625 | .534 | Rejected |
| Environmental uncertainty | -.269 | .129 | -.181 | -2.081 | .041 | Accepted |
| Dependent Variable: Budgetary_Control | | | | | | |

**Table 2:** Regression table

Above regression analysis table indicates that the acceptance and rejection of this research hypothesis based on the testing. The hypothesis is accepted if the sig value is below 0.05.

H1 (There is a relationship between accounting information/ control systems and budgetary control) is accepted, since the sig value is 0.001. H2 (There is a relationship between other departments and budgetary control) is rejected and supports the null hypothesis, since the sig value is 0.432. H3 (There is a relationship between organizational structure and budgetary control) cannot be proven since the sig value is value is 0.534, thereby supporting the null

hypothesis. H4 (There is a negative relationship between environmental uncertainties and budgetary control) is accepted, since the sig value is 0.041.

## 4. Conclusions

As per the literature review, Bushee et al., (2010) state that the accounting information system will increase accounting performance and reliability which will also support the budgetary control. In this analysis, the hypothesis is accepted proving a strong positive relationship between accounting information systems and budgetary controls. This is because, as a multinational conglomerate AMS uses SAP software which has a keen connection with their budgetary control. Furthermore, the regression also supports the hypothesis due to interdependence of budgetary control and accounting information system to obtain inputs at AMS healthcare. Therefore, the analysis reveals that accounting information has a significant effect upon budgetary control.

Based on the available researches, literature reveals that empirical research on HR management perspective (Cohen and Karatzimas, 2011) and marketing management practices in relation to budget are insignificant (Filiatrault and Chebat, 1987), since roles of other departments is not a key area of budgetary researches. In this analysis, the hypothesis is rejected, alternatively supporting the null hypothesis. This is supported by the regression value indicating above 0.05, which might be because AMS doesn't frequently involve non-departments in the budgetary process or their accounting information system is well managed, resulted in less visible interactions between departments, where the indirect flow of information was not detected in the analysis. The correlation between role of other department and budgetary control is proven as moderate and positive. Because, these departments provide valuable inputs for budget process. Anyhow, the objective is achieved with the clarification on the level of impact of role of other department in budgetary control.

As per the literature review Bruns (1975) highlighted budgets, helps to coordinate and control function of different parts of an organization. Organization structural changes as per the requirements, is a way to enhance effectiveness of budgetary control Bruns (1975). In this analysis, the hypothesis is rejected, hence alternatively supporting the null hypothesis. This is supported by the regression value indicating above 0.05, which is probably due to AMS use budgetary control as a standard management tool regardless of the structural changes. And AMS has a proper balance in their structure hence the budgetary control is not affected by any changes of the structure. The correlation between organizational structure and budgetary control is proven

as significant and positive. This could be because, organizational structure defines the line of authority and chain of command which helps the flow of information required for budgeting. Anyhow, the objective is achieved as the investigation has clarified the level of influence of organizational structure in AMS budgetary control.

Literature reveals that, when environmental uncertainty is low predictions are more accurate which reflects that environmental uncertainty has a significant impact on budgetary control (Govindarajan, 1984, 1988; Gul and Chia, 1994). In this analysis, the hypothesis is accepted proving the negative relationship. This could have been because crisis creates many uncertainties those could impact the budgetary control such as inflation, sudden tax rates and interest rates fluctuations and policy changes. One of these elements could have created a difference in their actual results and budgets of AMS. The negative relationship might have been supported by the regression value, since they were not having proper provisions for uncertainties, otherwise they might be using traditional budgeting system which is inherently inflexible to environmental dynamics. Therefore it has a significant impact upon the budgetary control.

This analysis has supported in effectively addressing realistic business recovery solutions for the problem. Via this analysis it is identified that the environmental uncertainties and weak role of other departments in AMS are the main cause for the budget variation. Possible business recovery solutions this study suggests to address and mitigate the problem are: if AMS is using traditional budgeting, they can shift to flexible budgeting, improve cross-functional collaborations and assign a team to continuously assess and plan for potential risks in the environment.

**Recommendations**

AMS can improve cross-functional communication and collaboration for budgetary inputs, since, even though managers will receive the required data for budget preparation and decisions, with the help of cross-functional collaboration further critical insights will be shared which will help in effective forecasting. This will enhance the relationship between roles of other department in budgetary control. On the other hand, with positive significant relationship still accounting information is in the moderate level. In order to strengthen the relationship, AMS can identify and adopt to more advance and effective accounting information system while increasing the cyber security to ensure the system doesn't result in inefficiencies in budget practices. Budget committee consisting of key stakeholders, including financial experts, department heads, and senior management can be implemented. This committee should oversee the budgeting process

and ensure adherence to financial goals. This would enhance the relationship between organizational structure and budgetary control. Furthermore, environmental uncertainties must be predicted and managed with proactive approaches. AMS must formulate a capable team in order to keep analyzing the market and updating the risk assessment and management plans. Because every day there can be ac new uncertainty born which might not be accurately noticed and prepare to be facing with weekly or monthly analysis. Then they can use multiple significant scenarios to create different sets of budgets to be proactive for the risk. And AMS can have a provision for environmental uncertainties in their budget planning while creating prior contingency plans to react effectively. Since lower the impact of uncertainty will lower the budget variance.

Despites these, this research could be further improved by addressing few loop wholes such as insufficient sample and using more accurate variables. SPSS results are mostly inaccurate when the sample size is smaller. Since in this research due to lesser sample size the system had errors in visualizing correct charts and graphs. Hence, researches must ensure to get samples at least above 100 if the employees are the target to improve the reliability of the data analysis. Using an independent variable (types of budget/ budgeting practices) to know the budgeting approaches the organization use would be related with high ethical responsibilities but researchers can identify the potential deviations (variance) by understanding the approach. For instance, if they use incremental budgeting, variations could result from past biases or wrong assumptions. Whereas, if judgments about resource allocation are not sufficiently justified, zero-based budgeting may result in variances. Understanding the budgeting approach enables to focus on essential elements and suggest focused solutions to efficiently address budget differences.

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# AN ANALYSIS OF IMPACT OF BRAND LOYALTY ON ONLINE COSMETIC PURCHASING BEHAVIOR OF FEMALE CONSUMERS IN COLOMBO SPECIAL REFERENCE TO XYZ COMPANY (PVT) LTD

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## Abstract

Cosmetics could be considered an indispensable commodity in contemporary society. Moreover, with the quick growth of the Internet, online shopping has evolved so rapidly that practically any product or service can be supplied online today. Therefore, the purpose of this study is to analyze brand loyalty on online cosmetic purchasing behavior of female consumers in Colombo. A survey was conducted to get information by sending a questionnaire to females who purchase cosmetics online. The study follows a convenient sampling technique to collect data; the researcher has distributed 300 questionnaires. For data analysis, SPSS was used as statistical software to look at descriptive, Cronbach's alpha, correlation analysis, simple regression, multiple regression, and multicollinearity. According to the research findings, the majority of females who purchase cosmetics online belong to the age group of 26-30 years. And also, findings revealed that brand name, cosmetic quality, and perceived value affect online cosmetic purchasing behaviors of female consumers positively and significantly. The study fulfills the existing research gap in the area of analysis of brand loyalty on the online cosmetic purchasing behavior of female consumers. This research can help cosmetic-related organizations learn about their consumers' opinions and also find solutions from the customers' perspective.

***Keywords***
Purchasing Behavior, Brand Name, Cosmetic Quality, Perceived Value

## Extended Abstract

## 1. Introduction

The cosmetics industry has seen tremendous growth, with brick-and-mortar businesses constantly needing to restock their shelves due to online products selling out in minutes. The cosmetics sector in Sri Lanka contributed up to 4% of worldwide e-commerce sales, boosting the industry's projected 20% sales growth in 2020. The beauty and cosmetics industry in Sri Lanka is expanding at an unprecedented rate. According to Statista statistics, the beauty and cosmetics category has grown at an annual rate of 8.7%, with a market value of $232.2 million that is expected to reach $355.10 million by 2025 (Statista, 2022).

According to the Census Department of Sri Lanka, the country's cosmetics market is growing at a rate of 15% to 20% per year. When compared to other beauty products, demand for skin-whitening products is driving the trend. The market is seeing an increase in demand for cosmetic and beauty products as people become more conscious of their looks and beauty. In all areas of cosmetics, manufacturers are likely to be proactive in determining the wants and requirements of consumers. Despite the fact that these studies have generated an outstanding body of literature on identifying the brand loyalty factors influencing cosmetic products, there are gaps that have prevented the study in this area from moving forward. Furthermore, in Sri

Lanka, the researcher could not find any reported evidence in this context in an analysis of brand loyalty in the online cosmetic purchasing behavior of female consumers in Colombo.

## 2. Methodology

It is necessary to analyze the brand loyalty that affects the online cosmetic purchasing behaviors of female consumers. The positivism philosophy is the ideal choice for organizing the research backdrop. The deductive approach is the research methodology used in this study, which tries to examine a hypothesis. In this study, the researcher used the quantitative approach. The researcher found that the data is required for the successful completion of this project, which needs quantifiable data to ensure that the results are plausible and justified. According to the census department of Sri Lanka, In 2019, the total population of females in Colombo was 3,120,000. Since there are no precise statistics on online female consumers in Colombo, by considering Morgan's sampling table, the sample size of this study is 300.

The researcher used non-probability sampling with a convenient sampling technique. Therefore, the researcher formed a Likert scale-type questionnaire in google form, sent out to female users on social media and messengers. The respondents are asked to score each statement in the Likert scale-type questionnaire.

## 3. Results and Discussion

The Statistical Package for Social Science (SPSS) was used to import the study's data for analysis utilizing descriptive statistics such as frequency distributions, percentages, and averages. Additionally, the link between independent and dependent variables will be examined using SPSS utilizing methods like Reliability analysis, Pearson's correlation coefficient, Linear regression, and Multiple linear regression.

**Table 01**. Reliability analysis.

| Factor | Cronbach's alpha value |
|---|---|
| Brand Name | 0.826 |
| Cosmetic Quality | 0.833 |
| Perceived Value | 0.835 |
| Online cosmetic purchasing behavior of female consumers | 0.815 |

Cronbach's alpha for all factors and the overall alpha value is greater than 0.7, as shown in Table. Furthermore, the first factor, brand name, consists of three questions with an alpha of 0.826. The second and third factors, cosmetic quality and perceived value, consist of three questions with an alpha of 0.833 and 0.835, respectively. The fourth factor, the online purchasing behavior of female consumers, consists of three questions with an alpha of 0.815. Therefore, the questions in each part of the questionnaire satisfactorily meet Cronbach's alpha-required reliability. As a result, the questions chosen are suitable for measuring the variables.

**Table 02**. Correlation & Regression analysis.

| | Brand Name | Cosmetic Quality | Perceived Value |
|---|---|---|---|
| β coefficient | 0.770 | 0.764 | 0.766 |
| t-statistics | 20.837 | 20.444 | 20.578 |
| *P* value | 0.000 | 0.000 | 0.000 |
| $R^2$ | 0.593 | 0.584 | 0.587 |
| Adjusted $R^2$ | 0.592 | 0.582 | 0.586 |
| F-statistics | 434.170 | 417.940 | 423.437 |
| Significance of F-statistics | 0.000 | 0.000 | 0.000 |

The simple correlation value is 0.770, which emphasizes that brand name and online cosmetic purchasing behavior of female consumers vary together 77% of the time. The $R^2$ value, also known as a coefficient of determination, is the percentage of total variation or dispersion in the dependent variable that can be explained by changes in the explanatory variables in a regression. As a result, the $R^2$ indicates that brand name can explain 59.3 percent of the variance in the correlation between brand name and female consumers' online cosmetic purchasing behavior. However, the remaining 40.7% of those differences remain unexplained in the error term. Also, the significant p-value of 0.000 means that the relationship among the variables is 100% real.

The simple correlation value was 0.764, and it revealed that cosmetic quality and female consumers' online cosmetic purchasing behavior vary together 76.4% of the time. The $R^2$ indicates that brand name can explain 58.2 percent of the variance in the correlation between cosmetic quality and female consumers' online cosmetic purchasing behavior. However, the remaining 41.8% of those differences remain unexplained in the error term. Also, the significant p-value of 0.000 means that the relationship among the variables is 100% real.

The simple correlation value was 0.766, and it revealed that perceived value and female consumers' online cosmetic purchasing behavior vary together 76.6% of the time. The $R^2$ indicates that perceived value can explain 58.7 percent of the variance in the correlation between perceived value and female consumers' online cosmetic purchasing behavior. However, the remaining 41.3% of those differences remain unexplained in the error term. Also, the significant p-value of 0.000 means that the relationship among the variables is 100% real.

**Table 03**. Multicollinearity test results.

| **Variable** | **Tolerance** | **VIF** |
|---|---|---|
| Brand Name | 0.331 | 3.023 |
| Cosmetic Quality | 0.281 | 3.555 |
| Perceived Value | 0.303 | 3.302 |

The values of centered VIF are less than 10. This shows multicollinearity is not presented among independent variables.

## 4. Conclusion

This chapter emphasized the importance of prior research and its findings. Then the researcher developed a questionnaire based on previous literature and distributed it among customers. After the data gathering, the gathered data were analyzed using the SPSS software. With the results of the study, the hypotheses developed were tested, and the findings of the present study revealed that brand name, cosmetic quality, and perceived value significantly affect the online purchasing behavior of female consumers. All these factors have a positive relationship with brand name, cosmetic quality, and perceived value. Furthermore, the researcher is able to conclude that if XYZ Company Pvt. Ltd. wants to increase the online cosmetic purchasing behavior of female consumers, they need to attract customers through their brand name and increase their cosmetic quality and perceived value to meet customers' expectations.

There are a number of suggestions and recommendations for the organization to consider in relation to the study. Younger female consumers are crucial because of their considerable influence, power, and interest. The results of this survey also showed that young women make up the majority of those who purchase cosmetics online. The company should thus work more to please youthful consumers. The company may provide more technologically advanced facilities and an online shopping experience to please those youthful users and draw in additional customers. With such development, the company can firmly establish the brand name with their target market. In order to match the expectations of its customers, the company should also concentrate on their cosmetic quality.

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Session 05

## Building Studies

# A COMPARATIVE STUDY OF COMPUTER-AIDED AND MANUAL COSTING TECHNIQUES FOR RESIDENTIAL HOUSE BUILDINGS IN SRI LANKA

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## Abstract

This research undertakes a comprehensive investigation into the cost estimation methods employed in the construction industry of Sri Lanka, specifically focusing on residential building projects. The study explores the comparative effectiveness of computer-aided costing techniques and traditional manual methods. To achieve this, a nationwide questionnaire was administered to professionals and individuals engaged in the costing of residential buildings. Through the analysis of survey responses, this research seeks to provide insights into the prevailing practices, identify the advantages and drawbacks of each approach, and ultimately contribute to improving cost estimation accuracy and efficiency within the Sri Lankan construction sector. The findings of this study hold significant implications for enhancing the cost management practices and sustainability of residential construction projects in Sri Lanka.

Key words: Computer-Aided Cost Estimation, Manual Cost Estimation, Cost Estimation in Residential House Buildings, Sri Lankan Construction

## Extended Abstract

### 1. Introduction

Amidst the ongoing expansion of the construction industry in Sri Lanka, residential house building projects have emerged as a central focus. In this dynamic context, the precision of cost estimation practices is pivotal, influencing project feasibility, budgeting accuracy, and overall outcomes. This research conducts a comprehensive comparative analysis of two prevalent cost estimation methodologies: computer-aided costing techniques, which harness specialized software applications for streamlined and accurate cost estimates, and traditional manual methods, relying on conventional, paper-based approaches and industry expertise. By engaging with industry professionals and practitioners through surveys, this research aims to illuminate the strengths, limitations, and overall effectiveness of these contrasting methodologies as they relate to residential construction projects in Sri Lanka. The findings of this study possess transformative potential, offering opportunities to enhance cost estimation practices within the Sri Lankan construction sector, ultimately leading to increased competitiveness, efficiency, and sustainability in residential house building projects, aligning with the nation's aspirations for growth and development in the 21st century.

The construction industry is a vital sector in Sri Lanka, contributing significantly to the country's economic development. Within this industry, cost estimation is a crucial process that impacts project feasibility and successful execution. A research by Chan and Kumarasway in 1997 has highlights the increasing use of computer-aided design

and project management software in the Sri Lankan construction industry. However, the advent of technology has ushered in a new era with computer-aided costing techniques gaining prominence. A study by Moravvati and Saeid in 2021 has explored this shift towards digital tools in cost estimation, the model-based cost estimation instead of traditional cost estimation can result in higher efficiency and fewer errors resulted. Many construction job costing software and tools can assist businesses in streamlining their financial reporting and construction project management processes. As Dobrowolska in 2023 cited, Archdesk, Joblogic, Contractor Foreman, Synergist, Procore and Amber-JCS are some of the construction job costing software. However, during the last decade, it appears that a fair degree of technology transfer was achieved with a fairly well-equipped technology and management base. But, still there is a lot more to achieve. Making use of IT in the construction industry is still at its adolescence stage though the IT industry is booming very fast (Silva, Rajakaruna and Bandara, 2008). As a contractor or estimator, you know how important it is to accurately estimate construction project costs. But projecting the material, labor, and equipment costs for a job can be a difficult task when done manually. Fortunately, the best construction estimating software will allow you to make quick and accurate estimates as you prepare your next bid. (Stormberg, 2020). A study by Shen Xu et al., in 2016 has encompassed elements of both cost estimation and information systems. It is understood that the incorporation of technological elements into the everyday undertakings of construction professionals has significant value, particularly with regard to time reduction within cost estimation activities. With the need to build more houses and infrastructure, quicker, to high quality and on time, there is a need to upscale the use of advanced technologies. Going digital is a solution that can transform the construction industry by improving productivity measures. (Chowdhury, et al., 2019) These findings provide context for our investigation into the suitability of computer-aided techniques.

As we embark on this research endeavor, it is clear that the construction industry in Sri Lanka stands at a pivotal juncture, where the choice between traditional manual costing and advanced computer-aided techniques will have far-reaching implications.

## 2. Methodology

This study, titled "Comparative Study on Costing Techniques in Sri Lankan Residential Construction," employs a cross-sectional survey design, distributing a structured questionnaire to a diverse sample of participants actively engaged in residential house construction cost estimation across various regions of Sri Lanka. This survey was done through distributing a set of questions regarding both computer aided and annual costing techniques. To conduct this, Google forms were distributed among 100 professionals from the construction industry including quantity surveyors, civil engineers, cost estimators etc. The gathered quantitative data, centered around participants' perceptions and preferences regarding computer-aided and manual costing techniques, are systematically analyzed using bar charts. Ethical considerations, encompassing informed participant consent and data security protocols, are strictly observed. While recognizing the potential for self-reporting bias and acknowledging the limitations inherent in sampling, this methodological approach provides a comprehensive and visually informative assessment of the relative effectiveness of costing techniques within the unique context of residential construction in Sri Lanka.

## 3. Results and Discussion

The survey results reveal significant trends in the perceptions of costing techniques within Sri Lankan residential house construction. First and foremost, a prevailing belief among participants is that computer-aided costing techniques provide more accurate cost estimates compared to manual methods, with 75% of respondents in agreement. This aligns with the broader industry trend of digitization and precision in cost estimation. Surprisingly, only 45% of participants claim familiarity with commonly used software for computer-aided cost estimation, indicating a potential need for increased awareness and training in utilizing these tools effectively. Efficiency is a key consideration, with a significant 90% of participants perceiving manual costing methods as more time-consuming than their computer-aided counterparts. This consensus underscores the efficiency benefits associated with computer-aided techniques, potentially influencing decision-making in the industry.

In terms of resource accessibility, the data is evenly split, with 50% of participants reporting access to the necessary resources for implementing computer-aided costing techniques. This suggests potential disparities in resource availability within the industry that may warrant further investigation and intervention. A surprising finding emerges regarding cost-effectiveness, as 75% of participants disagree that manual costing methods are more cost-effective than computer-aided techniques. This challenges the traditional notions of cost savings associated with manual methods and indicates a shifting perspective within the industry. Adequate training in using computer-aided costing software is crucial for proficiency, and the survey indicates that 63% of participants have received such training. This emphasizes the importance of training initiatives to enhance the industry's capabilities in employing these tools effectively. Ease of adjustments and revisions is an area where computer-aided techniques shine, with a significant 90% finding it easier to make adjustments using these methods. This flexibility further strengthens the argument for their adoption.

Furthermore, 95% of participants agree that manual costing methods are prone to more errors compared to computer-aided techniques, emphasizing the potential for error reduction through automation. The unanimous 85% consensus that computer-aided techniques are more suitable for large-scale residential projects highlights their scalability advantage, positioning them as a preferred choice for complex endeavors. Despite the advantages of computer-aided methods, 75% of participants express confidence in the accuracy of cost estimates produced by manual methods. This suggests that traditional practices still retain trust among a significant portion of professionals. Transparency enhancement is another strong point for computer-aided techniques, with 85% of respondents agreeing that they improve transparency in the cost estimation process. This consensus reflects the potential for greater clarity and accountability in digital workflows. In terms of flexibility, 65% of participants believe that manual costing methods are more flexible than computer-aided techniques, highlighting the perception of customization and adaptability with manual methods.

Interestingly, 74% agree that the integration of technology into cost estimation improves project management in residential construction, emphasizing the broader benefits of technological adoption. Access to historical cost data, a vital aspect of cost estimation, is a balanced 50/50 split, indicating potential variations in data availability within the industry. Additionally, 55% agree that manual costing methods allow for a deeper understanding of cost components, while 45% disagree. This highlights the value attributed to manual methods in gaining in-depth insights into cost structures.

Participants' preferences indicate a preference for a hybrid approach, with 75% favoring manual methods for initial cost estimates and computer-aided techniques for detailed cost analysis. This approach combines the strengths of both methods, recognizing their complementary roles. Moreover, a significant 80% disagree that computer-aided costing techniques require less expertise than manual methods, indicating a recognition of the need for proficiency in using digital tools. Customization of cost estimates to project-specific requirements is seen as an advantage of manual methods, with 67% in agreement. Finally, in terms of risk management, 73% agree that the use of computer-aided costing tools reduces the likelihood of cost overruns in residential construction projects. This highlights the potential for risk mitigation through technology adoption. 85% of respondents believe that the construction industry in Sri Lanka should prioritize the adoption of computer-aided costing techniques, indicating strong support for technological advancement within the sector.

In summary, the findings indicate a clear trend favoring computer-aided costing techniques in Sri Lankan residential construction, particularly in terms of accuracy, efficiency, error reduction, transparency, and scalability. However, the survey also highlights the importance of training and resource accessibility for harnessing the full potential of these digital tools. The preference for a hybrid approach suggests a recognition of the complementary roles of manual and computer-aided methods in the industry.

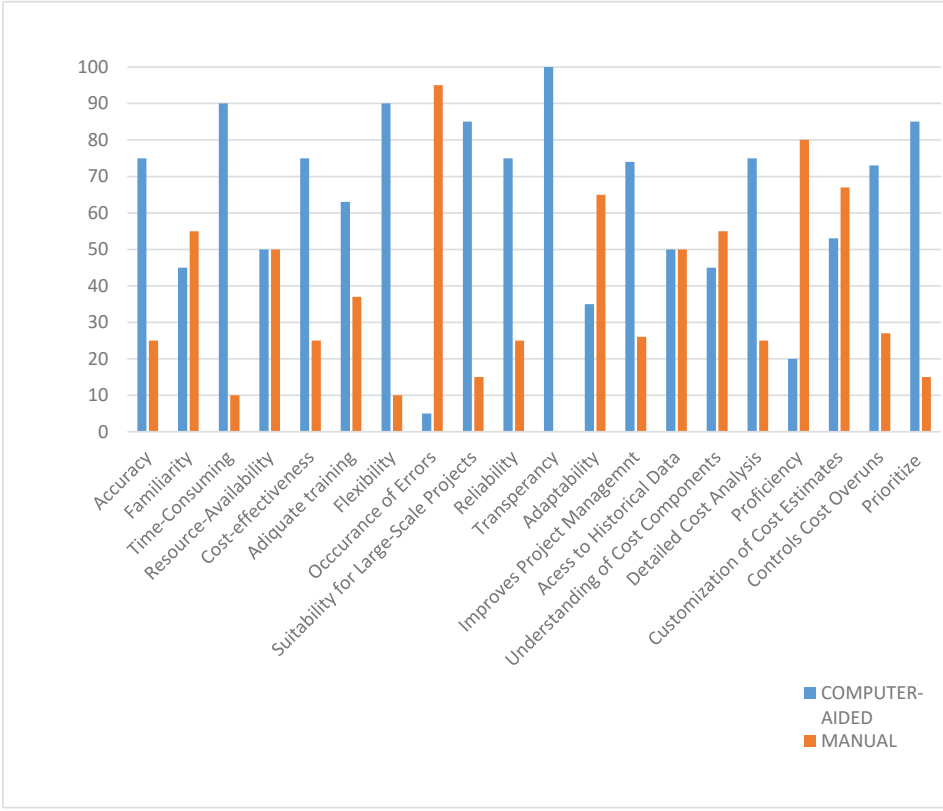


Figure 1 : Results Analysis

## 4. Conclusion

In summary, this research illuminates a clear shift in favor of computer-aided costing techniques in Sri Lankan residential construction, driven by their perceived advantages in accuracy and efficiency. The industry's unanimous call for prioritizing technology adoption signals a promising trajectory. While acknowledging the need for training and resource equity, this study underscores the potential for a harmonious coexistence of traditional and digital methods, paving the way for a more robust and adaptive cost

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# A CRITICAL EVALUATION OF CONDITIONS OF CONTRACT FOR DESIGN AND BUILD CONSTRUCTION PROJECTS: A COMPARATIVE STUDY BETWEEN FIDIC YELLOW SUITE AND CIDA/SBD/04

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## Abstract

This research compares FIDIC Yellow Suite and CIDA/SBD/04 in Sri Lankan Design and Build projects. It highlights the crucial role of contract conditions for consistent and effective project management. Factors like funding sources, employer traits, and contractor nationality influence contract selection. The study includes a literature review on the Design and Build system's history, FIDIC contracts, and CIDA conditions. Research methods encompass a documentary review, surveys, and expert interviews, uncovering challenges in document comprehension. Respondents suggest enhancements, including language clarity and modern practice clauses. In conclusion, CIDA/SBD/04 suits Sri Lankan projects, while FIDIC aligns with international standards. Foreign experts recommend FIDIC adoption to harmonize construction practices.

**Keywords:** Design and build projects, Conditions of contract, CIDA, FIDIC, Sri Lankan procurement practices.

## Extended Abstract

### 1. Introduction

The global construction industry has witnessed significant growth due to the world's rapid development, urbanization, and technological advancements. To manage the increasing complexity of construction projects, various approaches, including different contractual arrangements and procurement methods, have emerged. One such approach is the Design and Build contractual arrangement, where a single entity of the contractor handles both the design and construction works, which has gained popularity internationally and locally as well.

In the realm of such construction contracts, two sets of conditions of contract are widely recognized. The first is the FIDIC (The International Federation of Independent Consulting Engineers) color suite, which has the global acceptance. The second is the CIDA Conditions of Contract- Standard Bidding Documents (CIDA/SBD), only used in Sri Lankan construction procurement practices. The standard conditions of contract for Design and Build projects can significantly impact project fairness, management, and outcomes. These contracts aim to standardize and allocate rights and obligations for contractual parties and provide guidelines for effective project management, playing a critical legal and managerial role in the construction industry. (Rameezdeen & Shiyamasuntharan, 2010)

Standard contract conditions not only contribute to the successful completion of projects but also lead to cost reduction and improve time and quality control. They ensure that both

employers and contractors understand their respective duties, fostering collaboration towards project success. Additionally, conditions of contract assists employers in preparing tenders, evaluating bids, drafting contract documents, and managing the contract administration process.

However, the choice of contract conditions can vary due to factors such as funding sources, the nature of the employer (state or private), the nationality of contracting firms, and the procuring entity (local or international) etc. In this study, a critical evaluation of conditions of contract is conducted, focusing on the FIDIC yellow suite for Plant and Design-Build and the CIDA/SBD/04 for Design and Build contracts. The selected conditions of contract plays a vital role in shaping the construction landscape, offering consistency, clarity, and effective management for construction works. (Zylva et al, 1989).

The Design and Build procurement system, introduced as a modern approach to overcome issues associated with traditional procurement, has evolved significantly to meet the growing needs in both the private and state construction sectors. This system involves a design and build contracting firm responsible for both design and construction services. It can reduce costs, minimize disputes, and lead to earlier project completion. However, it may lead to less creative design, increased design risk for the contractor, and potential cost escalation due to limited competition. (Wardani & Messner, 2006)

In contrast, the FIDIC suite of contracts, established in 1913, offers standardized contract conditions for various types of construction projects. FIDIC contracts have evolved through different editions, focusing on civil engineering and construction projects. The fourth edition introduced an emphasis on the architect's impartiality in decision-making. FIDIC contracts are widely used globally and play a significant role in international construction projects. The FIDIC Yellow Book, a part of the FIDIC suite, addresses Plant and Design-Build contracts. In this arrangement, the contractor is responsible for designing and providing the works as per the employer's requirements, with an engineer overseeing the project. The use of dispute adjudication boards replaces the need to refer matters to the engineer's choice, improving dispute resolution. (Bunni, 2013)

In Sri Lanka, CIDA plays a crucial role in standardizing contract documents for the local construction industry. It was established in response to the boom in construction development between 1977 and 1987. The CIDA conditions of contract, first introduced in 1986 and revised in 1989, were modeled closely on FIDIC conditions with some modifications to suit local needs. The CIDA/SBD/04 emphasizes the contractor's role in design and construction, offering benefits to employers seeking a one-stop solution. (Ganeshan, 1991) These standard conditions of contract aims to streamline procurement processes, standardize contract documentation, and reduce the need for legal counsel, promoting consistency and fairness in the Sri Lankan construction industry.

## 2. Methodology

The research utilized three main methodologies:

***2.1 Documentary Review***: This qualitative analysis of documents encompassed descriptions of the Design and Build Procurement System, FIDIC contracts, CIDA conditions of contract, and their historical evolution, primarily addressing the first two research objectives of studying

and gaining knowledge on local and international procurement process for design and builds contracts and studying about the CIDA/SBD/04 and FIDIC yellow suit for conditions of contract.

***2.2 Questionnaire Survey***: Involving a set of 50 experienced professionals, including Quantity Surveyors, Civil Engineers, and Architects in the Sri Lankan Design and Build construction sector, with experience in both ICTAD and FIDIC contracts. This method quantitatively identified key differences, contributing to the third research objective of studying the main differences between the CIDA/SBD/04 and FIDIC yellow suit.

***2.3 Expert Interviews***: Qualitative interviews conducted with 05 expert professionals in the Sri Lankan construction industry, each possessing a minimum of ten years' experience in Quantity Surveying or Civil Engineering, and familiarity with CIDA and FIDIC contracts. These interviews enabled a comparative analysis and suggestions for improvements, facilitating the achievement of the last research objective of comparing the two conditions of contract and suggesting the improvements.

## 3. Results and Discussion

Based on the data collected and analyzed, the selection of either CIDA or FIDIC for construction contracts in Sri Lanka is primarily driven by the client's or funding agency's preferences. In many cases, the client is either the government or a local private entity, leading to the use of CIDA/SBD/04. Conversely, when the contractor is a foreign firm, FIDIC's yellow suite is often favored. Regardless of the project's nature, the choice of contract conditions is typically based on the type of client or contractor, making CIDA/SBD/04 common for Sri Lankan government-owned or funded projects and FIDIC yellow suite for foreign-funded or contracted design and build projects.

It's worth noting that the clarity and comprehensibility of contract clauses or the availability of sufficient information do not seem to be the primary factors influencing the selection of contract conditions. Respondents have highlighted challenges related to their understanding of these documents, often due to the complexity of the English language used. Some have also pointed out that these documents may lack adequate information on contract administration, construction claims, construction management, and dispute resolution, although specific clauses were not mentioned. However, some consider this lack of information a positive aspect since these conditions of contract are often the primary source for such information.

Language comprehension varies from person to person, so it can be concluded that the language barrier is more of an individual issue. Many respondents have mentioned that the FIDIC yellow suite is better organized and more suitable for their needs compared to CIDA/SBD/04. This is likely because the FIDIC yellow suite is specifically prepared for Plant and Design-Build contracts, offering more comprehensive information. In contrast, CIDA/SBD/04 mainly covers Design and Build construction projects.

Suggestions from the respondents include modifying the language in these documents to improve understanding. However, the language used in these contracts is generally accepted and legally binding. Some propose adapting CIDA to align with international construction practices, making it suitable for both local and foreign projects. Additionally, there is a call for including clauses related to modern Civil Engineering practices, such as Building Information Modeling (BIM), as there are no specific terms for computer-based design processes and costing systems in these documents.

Respondents have also suggested that both documents should provide more information on alternative dispute resolution methods. However, it's worth noting that these contracts already serve as major sources of information and legal procedures for alternative dispute resolution.

Overall, it seems that CIDA/SBD/04 is well-suited for Sri Lankan Design and Build construction practices, while FIDIC is considered better for adhering to internationally accepted standards, according to respondents who have experience with both. It's important to note that CIDA is based on FIDIC, which is a globally recognized series of contract conditions. (Logeswaran, 2011)

Foreign engineers participating in the survey have emphasized that most foreign countries prefer using the internationally accepted FIDIC series regardless of the funding sources or the client, consultant, or contractor's nationality. Unlike Sri Lanka, many countries don't have separate locally prepared series of contract conditions for each situation. Therefore, foreign experts suggest adopting the FIDIC yellow suite in Sri Lanka for both government and non-government design and build projects to bring the country's construction practices in line with international standards.

The following table summarizes more opinions and suggestions obtained from the questionnaire survey:

**Table 01**. Summary of the more options and suggestions obtained through the questionnaire survey

| ICTAD/SBD/04 | FIDIC yellow suite |
|---|---|
| • In Sri Lanka, used in government funded or local private funded projects with government/private contractor and a consultant. Except Sri Lanka, there is no international use. | • In Sri Lanka, used in foreign funded projects with foreign contractors, consultant where the client is the Sri Lankan government and internationally used in other foreign countries. |
| • Prepared only for Design and Build projects. | • Prepared for Plant and Design Build projects. |
| • Practiced only within Sri Lanka. | • Internationally accepted and practiced including Sri Lanka. |
| • Prepared based on FIDIC. | • Prepared by own. |
| • Provides sufficient information on contract documentation. Construction management, dispute resolution, construction claims etc. | • Provides sufficient information on contract documentation. Construction management, dispute resolution, construction claims etc. |
| • Complexity of language that leads to less understandability and ambiguity. | • Complexity of language that leads to less understandability and ambiguity. |
| • Lack of information. | • Includes information that is not included in CIDA/SBD/04. |

| | |
|---|---|
| • Should be modified in order to suit with international construction practices and requirements as well. | - |
| • The content should be well arranged. | - |
| • It should more define the duties and responsibilities of the contracting parties. | - |
| • Should me modified according to modern construction practices. | • Should me modified according to modern construction practices. |
| • Locally accepted standard. | • Internationally accepted standard. |

## 4. Conclusions

In conclusion, the choice between CIDA and FIDIC for construction contracts in Sri Lanka is predominantly driven by the preferences of the client or funding agency. The selection often depends on whether the client is a government entity or a local private organization, with CIDA/SBD/04 commonly used for government-owned or funded projects, and FIDIC yellow suite favored for foreign-funded or contracted design and build projects.

The analysis indicates that factors such as the clarity of contract clauses or the availability of information do not appear to be the primary determinants in the selection process. Challenges in understanding these documents are often attributed to the complexity of the English language used, with some respondents suggesting modifications to improve comprehension. Notably, while the FIDIC yellow suite is considered better organized and more suitable for respondents' needs, CIDA/SBD/04 is deemed well-suited for Sri Lankan Design and Build construction practices.

Suggestions from respondents include adapting CIDA to align with international construction practices and incorporating clauses related to modern Civil Engineering practices like Building Information Modeling (BIM). Additionally, there is a call for more information on alternative dispute resolution methods in both documents.

Foreign engineers emphasize the preference for the internationally accepted FIDIC series in many countries, regardless of funding sources or the parties involved. They propose adopting the FIDIC yellow suite in Sri Lanka for both government and non-government design and build projects to bring the country's construction practices in line with international standards.

In summary, the study highlights the influence of client characteristics on contract selection, the language-related challenges faced by respondents, and the contrasting strengths of CIDA and FIDIC in catering to specific project types. The suggestions put forth by respondents, particularly the call for aligning with international standards, reflect a broader consideration for the future development of Sri Lanka's construction practices.

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# A STUDY ON HEALTH & SAFETY MEASURES OF LABOURERS IN HIGH-RISE RESIDENTIAL BUILDING CONSTRUCTION IN COLOMBO

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## Abstract

Due to the unique nature of the tasks involved and the recurrence of various building operations, construction has become a risky vocation. High-rise construction sector development has a direct influence on the country's economy and it plays a vital part in its growth and construction on the other hand, is risky due to a high rate of accidents and fatalities, as indicated by distressing accident and mortality figures. This scenario shows the significance of recognizing the safety variables that contribute to high-rise building accidents. As a result, the study was divided into two sections. The first part of the research focused on identifying the requirement of health and safety measures for high-rise residential (apartments) buildings in the construction industry, while the second part focused on investigating the existing safety measures, policies, regulations, and risk prevention practices in construction projects in Colombo, the capital of Sri Lanka. The study was also focused on evaluating the applicability of modern safety technologies and measures, safety programs, and solutions and finally focused on recommending feasible safety measures for the high-rise construction industry in Sri Lanka. Furthermore, a methodology for assisting construction project managers in analyzing the safety aspects connected with high-rise building projects has been presented. As a result, this framework laid the groundwork for future academics to apply in high-rise construction projects.

**Key words** – Construction Health & Safety, High-Rise Residential Buildings, Construction Accidents and Fatalities, Modern Safety Technologies

## Extended Abstract

### 1. Introduction

The construction industry in Sri Lanka is vital for the country's economy, but it faces significant challenges in ensuring worker safety. According to the Health and Safety Executive – UK records in the construction industry, inadequate safety practices, particularly in high-rise apartment projects, have led to a rise in accidents and fatalities. The identified hazards include physical injuries and chemical exposures. Efforts should be made to prioritize and improve safety measures in the industry to mitigate these risks.

Hazards that can be seen on a daily basis can be listed as follows,

**Table 01**. Physical and chemical hazards in construction

| Physical injury hazards | Chemical injury hazards |
|---|---|
| • Scaffold-related injury | • Inhaling asbestos while working |
| • Electrical incidents | • Airborne & material exposure |
| • Material handling | • Welding fumes |
| • Burns | • Spray paints |
| • Vibration-related injury | • Cutting oil mists |

Poor site safety practices stem from employers' failure to follow safety procedures, leading to two main types of hazards on construction sites. Lack of safety awareness and reluctance to wear Personal Protective Equipment (PPE) are major issues, often due to workers' limited knowledge of risks. Inadequate provision of PPE, including helmets, gloves, goggles, and ear protection, further exacerbates the problem. Insufficient understanding of site security and regulations, improper implementation of safety signs, and the absence of a safety officer contribute to compromised safety and harm the construction company's reputation. Other factors include the lack of safety training facilities, workers under the influence of substances, and unsafe behaviors like unauthorized machinery operation. (Walawage, 2015)

Sri Lanka's high-rise construction companies neglect safety regulations and practices, prioritizing project completion and cost-cutting. Worker reluctance and inadequate monitoring contribute to accidents. Lack of funding, focus, commitment, education, and legislation are key concerns in Sri Lanka's construction industry safety. (Perera, 2017). Construction site is a workplace which exists a lot of hazardous activities and accidents. Due to the frequent development of high-rise buildings in the capital of Sri Lanka, more attention should be paid to safety and health issues in the construction-industry. In high-rise residential buildings, the most common accidents are workers falling from heights and injuries from falling objects (Goh, et al., 2016).

Another researches conducted by Raufdeen Rameezdeen, Chaminda Pathiraga, and Saman Weerasuriya (2003) demonstrated that any type of health and safety management program can be the initial step for identifying hazards or disaster situations in the work environment. Construction accident injuries have serious adverse consequences, including personal suffering for the worker, construction delays and loss of productivity incurred by the construction company, higher insurance premiums due to costly injuries, and potential liability for all parties involved in the project. The number of annual fatal accidents in the construction sector is high compared to other sectors (Rameezdeen, et al., 2003).

The construction industry faces various hazards such as falls, electrical shocks, and exposure to hazardous materials, with poor safety practices attributed to a lack of awareness and reluctance to wear PPE. The sector has a high rate of accidents and fatalities compared to other industries, and implementing safety measures, including technology, coordination, and training, is crucial for improving occupational safety. International construction projects pose additional challenges due to diverse stakeholders and labor-related issues (Vitharana, 2017).

## 2. Methodology

This research adopts an interpretivist philosophy and follows an inductive approach and the study aims to investigate the current usage of health and safety measures in the construction industry in the capital of Sri Lanka. The research involved a literature review to identify existing

practices, followed by a questionnaire survey. Careful consideration was given to ensure accuracy and reliability of data collection. Statistical analysis of the collected data facilitated meaningful discussions and recommendations.

## 3. Results and Discussion

Based on the information collected from the questionnaire, 75% of the responses indicated that the health and safety is a very important consideration in high-rise residential building construction in Colombo and the majority of construction sites (78.1%) reported conducting regular health and safety meetings. This indicates that these sites recognize the importance of holding such meetings and likely use them as a means to address and ensure safety protocols and practices. On the other hand, 21.9% of the questionnaires indicated that no meetings were being conducted on the sites surveyed. This suggests that a significant portion of the sites may not prioritize or have a structured approach to Health and Safety meetings.

The most common frequency of Health and Safety meetings reported by sites is "occasionally" and "once a week," with both categories representing 31.3% of the respondents. This suggests that a significant number of sites conduct these meetings either on an ad-hoc basis or on a weekly schedule and only 12.5% of the respondents mentioned that they have not yet attended any Health and Safety meetings. This suggests that the majority of sites have engaged in these meetings to some extent.

According to the results, the most common accident type is "Falling from Heights. The second most common accident type is "Electrical shock & accidents related to machinery," with a frequency of 46.9%. "Falling Ladders, Trips and Slips" also has a frequency of 28.1%.

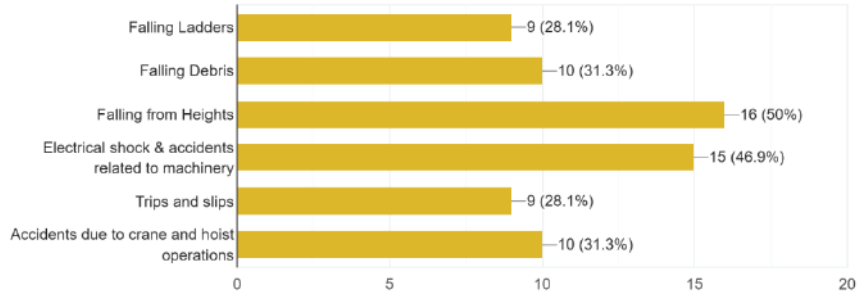


Figure 01: The most common accidents in high-rise construction

Based on the information provided from the questionnaire graph, the study identified several factors affecting Health and Safety management in high-rise residential building construction. The participants were asked to select the most suitable factor. Safety training and awareness received the highest percentage of votes, with 63.3% of participants selecting it as the most suitable factor for improving Health and Safety management in high-rise construction.

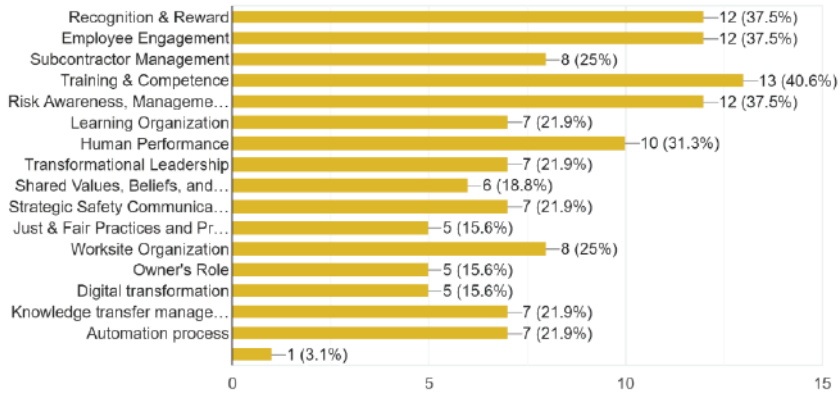


Figure 02: The Operational Excellence Model to improve Health and safety for construction

This figure 02 above focuses mostly on how to enhance the health and safety practices for high-rise residential building development in the capital of Sri Lanka. Recognition and reward, Employee Engagement, Subcontractor Management, Training and competence, Risk awareness, Management & Tolerance, Learning Organization, Human Performance, Transformational Leadership, Shared Values, Beliefs, and Assumptions, Strategic Safety Communication, Just & Fair Practices and Procedures, Worksite Organization, Owner's Role, Digital transformation, Knowledge transfer management, Automation process are some of the concepts.

According to the survey results, most of the responses suggested sensing and warning technologies, smart sensors, and wireless networks are the most effective modern methods and technologies for assuring the health and safety in high-rise residential constructions and their percentage is 37.5%. Furthermore, the lowest number of people suggested (28.1%) Automation and robotics, 4DCAD as effective technologies, prevention, and safe project delivery.

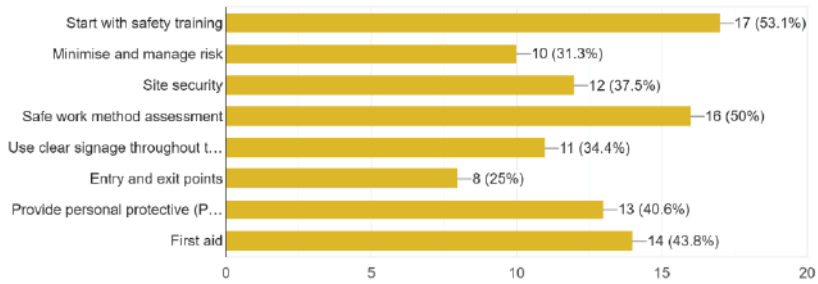


Figure 03: Possible safety measures for the high-rise construction industry

According to Figure 03, most of them responded the most suitable safety measure is to give safety training for the employees. This amount is 53.1% and secondly most of them suggest safe work method assessment its 50%. And the lowest number of people were suggesting the marked the entry and exit points. However, if the responsible person in site who has better knowledge about health and safety measures and first aid knowledge is also very important for the high-rise residential building construction industry.

## 4. Conclusions

Construction has gotten riskier as a result of an increase in operational complexity. The issue for the high-rise residential construction industry is to closely monitor their labor safety management systems in order to reduce workplace dangers. One of the most important elements to consider before commencing any construction project is health and safety. Before you set foot on a high-rise residential building construction site, make certain that all aspects of health and safety have been taken into account. High-rise construction health and safety is very important since the industry is exposed to hazardous conditions and can be dangerous in specific instances. According to data, 3% of all construction workers in the world suffer from a work-related injury, and 4% suffer from a work-related sickness. This might result in substantial time lost from work and individuals growing dissatisfied with their careers. Workplace health and safety is essential for a variety of reasons.

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# A STUDY ON PROMOTING EFFECTIVE SOLID WASTE MANAGEMENT PRACTICES FOR BUILDING CONSTRUCTION PROJECTS IN SRI LANKA

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## Abstract

The construction industry in Sri Lanka has experienced significant growth due to the country's economic development. However, this growth has resulted in an alarming increase in solid waste generation at construction sites. The management of solid waste poses a major challenge for the construction sector in Sri Lanka, as it directly impacts project profitability and unit rates. Approximately 40% of waste is generated by the construction industry, primarily due to a lack of awareness among contractors and inadequate site organization. This research aims to identify and promote effective solid waste management practices for building construction projects in Sri Lanka. The objectives include recognizing common types of solid waste, investigating waste generation sources and responsible parties, exploring the impacts of construction solid wastes, researching major materials used in Sri Lanka, and providing suggestions and solutions to reduce waste generation through effective waste management practices. However, this study is limited to building projects executed by contractors classified as Grade 1-4 by the CIDA. The findings of this research will contribute to enhancing waste management practices in the construction industry, thereby maximizing project profitability and sustainability.

**Keywords :** Waste management, Solid waste, Construction industry, Waste sources

## Extended Abstract

### 1. Introduction

This research focuses on the management of solid waste materials in the construction industry in Sri Lanka. It highlights the lack of a proper waste management system in the country, unlike developed nations. The study aims to identify the main types of solid waste and determine the individuals or entities responsible for its generation. Factors contributing to waste production include inappropriate construction methods, poor planning, inadequate cost control, and communication issues. The impact of solid waste on the environment and costs are also briefly discussed. (Kubba, 2010)

This research aims to address the growing issue of solid waste generation in the construction industry of Sri Lanka, which has been amplified by the country's economic growth and development. The objectives of the research include identifying common types of solid waste

in building construction, examining the sources of waste generation and responsible parties for waste management, exploring the impacts of construction solid wastes, researching and quantifying the major materials used in Sri Lanka, and providing suggestions and solutions to reduce waste generation through effective waste management practices. The study is limited to building projects executed by contractors classified as Grade 1-4 by the ICTAD. (Watson, 1985)

The construction industry in Sri Lanka has witnessed significant growth in recent years, contributing to economic development. However, this growth has also resulted in a substantial increase in solid waste generation at construction sites. Effective solid waste management practices are crucial to mitigate the environmental and economic impacts associated with construction waste. This literature review aims to explore existing research and studies related to solid waste management in the construction industry in Sri Lanka, focusing on waste generation, sources, impacts, and potential solutions.

The construction industry is a major contributor to solid waste generation worldwide. In Sri Lanka, studies have shown that approximately 40% of waste is generated by the construction sector (Wijesiri et al., 2018). The primary sources of construction waste include excavation materials, concrete, bricks, timber, packaging materials, and other construction-related debris (De Silva et al., 2019).

Improper management of construction solid wastes can have significant environmental and economic impacts. The accumulation of waste at construction sites can lead to visual pollution, soil and water contamination, and the release of hazardous substances (Wijesiri et al., 2018). Moreover, waste disposal costs and potential fines for non-compliance with waste management regulations can negatively affect project profitability (Jayathilake et al., 2016).Several factors contribute to solid waste generation in the construction industry in Sri Lanka. These include poor site organization, lack of awareness and training among contractors and workers, inadequate waste segregation practices, and insufficient resource planning (De Silva et al., 2019; Wijesiri et al., 2018). Additionally, the use of low-quality materials and improper handling and storage techniques can result in higher wastage (Jayathilake et al., 2016).

Various waste management practices and solutions have been proposed to address the challenges of solid waste management in the construction industry. (Jayathilake et al., 2016). These include waste minimization, recycling and reuse of materials, improved storage and handling techniques, and proper waste segregation and disposal (De Silva et al., 2019) Additionally, the adoption of waste management plans, the establishment of on-site waste management facilities, and the implementation of waste management regulations and guidelines can contribute to effective waste management (Wijesiri et al., 2018).

Despite the availability of waste management practices, several challenges and barriers hinder their effective implementation in the construction industry in Sri Lanka. These include a lack of awareness and education among contractors and workers, limited enforcement of waste management regulations, inadequate infrastructure and facilities for waste segregation and disposal, and cost considerations.

## 2. Methodology

In this study, various sampling methods are utilized to select the firms and respondents. Sri Lankan contractors are categorized into grades (C1 to C9) based on their financial and technical capacity. Questionnaires are distributed to C1 to C4 contractors for research purposes. The data gathering process involves reconsidering the questionnaires and preparing survey questionnaires. Field data is collected from different sites in Sri Lanka. Data investigation is conducted using percentages, means, and graphs for analysis. The data analysis section focuses on analyzing the collected data from the respondents, employing suitable techniques based on the nature and structure of the information. (Yu, 2021)

## 3. Results and Discussion

30 numbers of questionnaires were sent construction sites, but only 21 numbers of questionnaires were received.

**Table 01**. Percentages of responses from different construction company categories

| Grade | Number of posted | Number of responded | Percentage of responded |
|---|---|---|---|
| C1 | 12 | 7 | 58.3% |
| C2 | 9 | 8 | 88.8% |
| C3 | 6 | 4 | 66.6% |
| C4 | 3 | 2 | 66.6% |

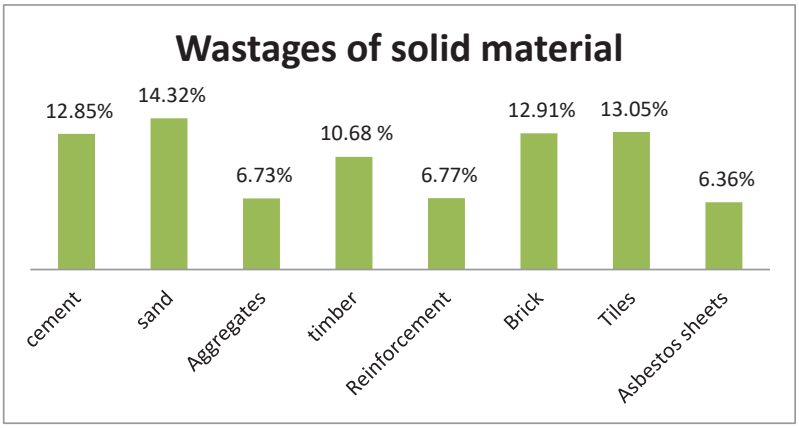


Figure 1 : wastages of each solid materials in western province sites

Based on the data analysis, sand is identified as the primary solid waste material in building construction projects in the western province, accounting for 14.32% of wastage. Tiles rank second with a wastage rate of 13.05%. Tiles are prone to cracking during transportation and handling, making them a sensitive material. The waste of sand is mainly attributed to improper storage and the use of low-quality sand. Bricks and cement exhibit similar levels of wastage. Asbestos sheets have the lowest wastage, but it is crucial to minimize waste in this material due to its harmful impact on the environment. Based on these findings, it is recommended to implement waste minimization systems for materials such as sand, tiles, bricks, and cement, as they exhibit higher wastage compared to other materials.

Following pie chart shows total percent wastage of each material. Sand contributes 17% of waste for total solid waste of western province construction wastes.

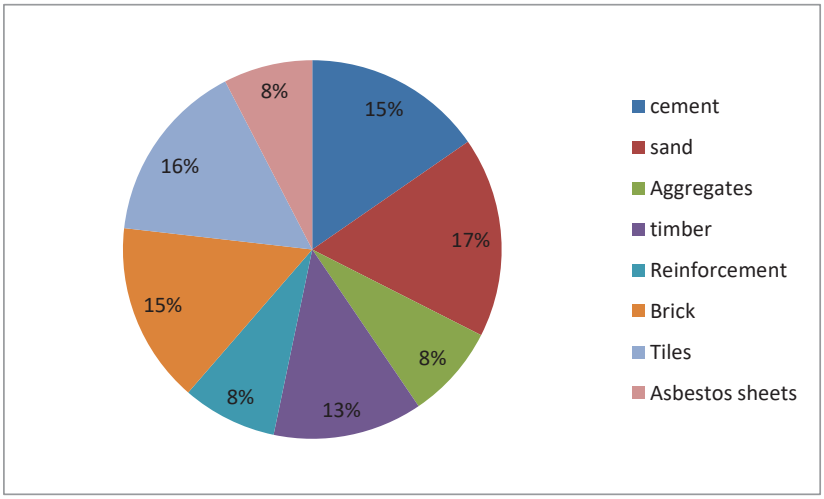


Figure 2 : Total percent wastage of each material in western province sites

Relative Importance Index (RII) tool were used for analyze the data collected from question of questionnaire to investigate the sources and responsible parties for construction solid waste. To determine RII factors, the mean values of respondents' answers should transformed to importance indices based on the following equation. (Tam *et al.*, 2000)

$$RII = \frac{\sum W}{AN}$$

Where;

W = weight of the each factor

A = Highest weight

N = Number of samples

**Table 01**. Major causes of solid waste in western province building sites (N=21)

| Causes | ∑W | RII | Ranking |
|---|---|---|---|
| Wrong and lack of material storage | 79 | 0.90 | 1 |
| Damage during transportation | 74 | 0.84 | 2 |
| Leftover materials | 66 | 0.75 | 3 |
| Poor quality of materials | 55 | 0.63 | 4 |
| Wrong handling of materials | 43 | 0.61 | 5 |
| Frequent design and client's changes | 50 | 0.57 | 6 |
| lack of experience of skilled workers | 44 | 0.50 | 7 |
| Poor quality and non-availability of equipment | 38 | 0.43 | 8 |
| Theft | 35 | 0.40 | 9 |
| Weather conditions | 35 | 0.39 | 10 |
| Poor site conditions | 29 | 0.33 | 11 |

The factors with RII values above 0.75 (75%) are considered to have a high impact on building construction waste in the western province. The main causes identified are improper material storage, transportation issues leading to wastage of materials like bricks and tiles, and leftover materials on-site. Store-keepers, project managers, and site engineers should address these issues. Weather and site conditions have minimal influence on waste, but recycling leftover materials is an effective waste management strategy.

## 4. Conclusions

In conclusion, valuable insights into construction solid waste in the western province of Sri Lanka are provided by this research study. A comprehensive understanding of the issue is facilitated by the methodology employed, which involves the utilization of various sampling methods and the collection of data from different sites. The primary sources of waste are revealed by the data analysis, with materials such as sand, tiles, bricks, and cement being highlighted.

The importance of waste minimization systems is emphasized by the study, and specific issues related to material storage, transportation, and leftover materials on-site are recommended to be addressed. By focusing on these areas, a crucial role can be played by store-keepers, project managers, and site engineers in reducing construction solid waste.

Furthermore, the significance of recycling leftover materials as an effective waste management strategy is emphasized by the research. This approach not only helps in waste reduction but also contributes to sustainable construction practices.

Overall, valuable information for policymakers, construction professionals, and stakeholders in Sri Lanka's construction industry is provided by the findings of this study. By implementing the recommended waste minimization systems and addressing the identified issues, the industry can be moved towards more sustainable and environmentally friendly practices, thereby contributing to the overall development and well-being of the country.

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# AN EXPERIMENTAL STUDY ON EFFECT OF ADMIXTURES ON THE PROPERTIES OF CONCRETE WITH RECYLED CONCRETE PARTIALLY REPLACED AS COURSE AGGREGATES

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## Abstract

The escalating demand for construction globally, fueled by population growth and infrastructure needs, has led to resource depletion, necessitating sustainable alternatives. Recycled aggregate, offering a cost-effective and eco-friendly solution, addresses construction waste concerns. Despite concrete's historical prominence, its resource-intensive nature and waste generation during demolition raise environmental issues. In Sri Lanka, where construction waste reaches 4.0 million tons annually, incorporating recycled concrete aggregate (RCA) becomes imperative. This research explores the feasibility of using recycled concrete as coarse aggregate, emphasizing the application of admixtures (plasticizers, retarders, and accelerators) to enhance concrete properties. The study focuses on a mix design where 30% of coarse aggregates are replaced with recycled concrete, considering the potential impact of varying admixture percentages (0%, 0.5%, and 1.0%).

Key words: Recycled Concrete, Construction Waste, Admixtures, Strength of Concrete

## Extended Abstract

### 1. Introduction

The construction industry, a global powerhouse, faces increased demand due to the population growth and the need for housing and infrastructure. However, this surge in construction has led to the depletion of raw materials. To address this, researchers have explored alternative materials, with recycled aggregate emerging as a cost-effective and eco-friendly solution, reducing construction waste.

Concrete, the primary construction material, offers adaptability and resource conservation. Yet, the demolition of structures generates waste concrete, impacting the environment significantly. In Sri Lanka, the annual production of 4.0 million tons of construction waste has become an environmental concern. The concrete industry's resource-intensive nature and $CO_2$ emissions necessitate eco-conscious practices, like incorporating recycled concrete aggregate (RCA).

Recycling concrete is a cost-effective option, particularly when compared to establishing new quarries, which are expensive. In urban areas, limited landfill space far from the city increases disposal and transportation costs

Concrete has a history of over 2000 years and its technology has come a long way. It is main construction material in construction industry. For its adaptability and suitability of concrete must conserve resources. Concrete is composite material, it has cement, fine and cores aggregate, water and admixtures are use as its component. Coarse and fine natural

aggregates contain around 70% of entire concrete volume in concrete mix. To estimates entire world demand more than 20 billion tons annually for construction. (Manjunath M, 2015)

Sri Lanka is a one of developing countries in the world and construction industry support to 7% of the GDP. Nowadays mega construction projects start in Sri Lanka, high rise buildings, air ports etc. more construction projects are to be expected in future and construction volume in Colombo district is very high and generate of construction demolish waste is also high. Reuse and recycle is the best solution for this matter. (Kumara, 2009). Recycle concrete is still not popular in Sri Lanka. But can apply in miner construction project. Limited numbers of researchers performed in Sri Lanka for assessment the recycled concrete achievement. (Deiyagala, et al., 2017)

Admixtures in concrete are powder or fluids materials that are used to offer those features, which cannot be achieved with plain concrete and are needed to be added just before or during mixing. (Bye & Livesey, 2015) Set retarding admixtures are used to postpone the chemical reaction that takes concrete start the setting process. High temperature of fresh concrete (30°C) increased the rate of hardening, and it is difficult to placing and finishing. Most commonly reduce the heat of concrete by cooling the mixing water or aggregate. Retarder admixtures are normally use to extending the setting time, but it can also use to reducing slump losses and enhancing workability. (Dodson, 2013) The main advantage of plasticizer is high range of water reducer. Plasticizers are mix with fresh concrete and improve the low-slump to normal-slump, and enhancing the workability of concrete. Plasticizers convert concrete to highly fluid concrete and accelerating admixtures are used to increase the hydration levels and get an early age strength.

## 2. Methodology

For this experimental research, a set of 45 concrete cubes of grade 30 (1:1:2) were prepared by partially replacing the volume of the coarse aggregates with 30%. The admixtures used for the experiment were plasticizers, retarders and accelerators, in which the amounts mixed were 0%, 0.5% and 1.0% from the weight of cement used. The prepared concrete cubes were tested in 28 days by using a crushing machine and the compressive strengths were determined.

**Table 01**. Partial replacement of recycled concrete as coarse aggregate

| Cement | Fine aggregate | Coarse aggregate | |
|---|---|---|---|
| | | Natural | Recycle concrete (30%) |
| 1.0 | 1.0 | 1.4 | 0.6 |

**Table. 02** Mix design ratios

| Percentage of admixture | Cement | Fine aggregate | Coarse aggregate | |
|---|---|---|---|---|
| | | | Natural | Recycle concrete (30%) |
| 0% | 1.0 | 1.0 | 1.4 | 0.6 |
| 0.5% | 1.0 | 1.0 | 1.4 | 0.6 |
| 1.0% | 1.0 | 1.0 | 1.4 | 0.6 |

## 3. Results and Discussion

**Table 03**. Average compressive strength of aggregate replaced concrete with set retarders

| Admixture percentage | Average Compressive strength (N/mm²) |
|---|---|

| | (45 test cubes) |
|---|---|
| 0% | 29.661 |
| 0.5% | 29.845 |
| 1.0% | 28.723 |

The table presents the average compressive strength values of concrete cubes subjected to varying percentages of admixture. The average compressive strength for the control group, with no admixture (0%), was found to be 29.661 N/mm². Introducing a 0.5% admixture resulted in a slightly higher average compressive strength of 29.845 N/mm², showing a marginal increase compared to the control group. However, the compressive strength exhibited a decrease when the admixture percentage was further increased to 1.0%, with an average value of 28.723 N/mm².

The observed trends in compressive strength suggest that the influence of the admixture on concrete performance is not uniformly positive. While a small percentage (0.5%) of admixture led to a modest improvement in compressive strength, a higher percentage (1.0%) had a negative impact on the strength of the concrete.

**Table 04.** Average compressive strength of aggregate replaced concrete with super plasticizers

| Admixture percentage | Compressive strength (N/mm²) (35 test cubes) |
|---|---|
| 0% | 30.145 |
| 0.5% | 30.630 |
| 1.0% | 29.885 |

The control group, with no admixture (0%), exhibited an average compressive strength of 30.145 N/mm². The introduction of a 0.5% admixture led to a notable increase in compressive strength, with an average value of 30.630 N/mm². Further, when the admixture percentage was increased to 1.0%, the compressive strength remained high, with an average value of 29.885 N/mm².

The observed trends in compressive strength suggest a positive impact of the admixture on the concrete's mechanical properties. The incremental increase in strength with the addition of the admixture, particularly at the 0.5% concentration, indicates a beneficial effect on the overall performance of the concrete.

**Table 05.** Average compressive strength of aggregate replaced concrete with accelerators

| Admixture percentage | Compressive strength (N/mm²) (45 test cubes) |
|---|---|
| 0% | 28.623 |
| 0.5% | 28.112 |
| 1.0% | 29.994 |

The control group, without any admixture (0%), exhibited an average compressive strength of 28.623 N/mm². Introducing a 0.5% admixture resulted in a slight decrease in compressive strength, with an average value of 28.112 N/mm². However, the compressive strength increased notably when the admixture percentage was further raised to 1.0%, with an average value of 29.994 N/mm².

The observed trends in compressive strength suggest that, in this study, the admixture at a 1.0% concentration positively influenced the concrete's mechanical properties. The increase in compressive strength could be attributed to various factors, such as improved workability, enhanced cement hydration, or a favorable interaction between the admixture and other components in the concrete mix.

## 4. Conclusion

In the pursuit of optimizing concrete performance through the incorporation of set retarders, super plasticizers, and accelerators, this research has provided valuable insights into the influence of varying admixture percentages on the compressive strength of concrete cubes.

The observed variations in compressive strength emphasize the critical role of precise admixture dosage in optimizing concrete performance. While super plasticizers and accelerators at higher concentrations demonstrated positive effects, set retarders exhibited diminishing returns on compressive strength. However, addition of the admixtures in percentages has ultimately been able to achieve at least 99% strength of the grade 30.

It is essential to consider that the concrete industry constantly seeks sustainable practices, and the incorporation of admixtures plays a pivotal role in achieving eco-conscious and efficient construction. The findings of this research contribute to the ongoing dialogue surrounding the use of admixtures in concrete, highlighting the need for careful consideration of dosage and type to achieve desired performance outcomes. Further studies and in-depth analyses are encouraged to explore additional properties and long-term effects, promoting sustainable advancements in the field of concrete technology.

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# IMPACT OF LOW-BID CONTRACTS ON THE SRI LANKAN BUILDING CONSTRUCTION INDUSTRY IN TIME, COST AND QUALITY

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## Abstract

Low-bid construction is a procurement method that involves selecting the lowest-priced contractor for a construction project, regardless of other factors such as quality, performance, and value. It is often used by owners or developers who want to save money on their projects, but it can have many risks and disadvantages for them and contractors. This is a risky procurement method that can harm both owners and contractors in various ways. It can lead to pricing disputes, deficient quality, and low performance on the project. A better approach is to focus on value rather than price and to collaborate with contractors who can offer their expertise, experience, and creativity to deliver a successful project. Some alternative approaches that can achieve this are negotiated tendering and value engineering. These approaches can lead to better outcomes for everyone involved in the project. This research is anticipated on determining the impact of low-bid contracts on the Sri Lankan building construction industry in terms of the time, cost and quality of projects.

**Keywords**: Low-bid construction, low-bid contracts, pricing disputes, deficient quality, value engineering

## Extended Abstract

### 1. Introduction

In Sri Lanka, a contractor is selected through a bidding procedure for construction projects and this will be a decisive step toward project implementation. The most widely used tender procedure in Sri Lanka is the Government Bid Evaluation Procedure (GBEP), and many projects are in charge of the client.

There are many construction companies involved in government construction projects and the newly established companies will try to make their image among the government institutes. Therefore, they tend to present very low bidding rates to win the tenders. But there are also experienced contractors and they know the construction could not meet the client's requirements by presenting much lower rates. Then they have high rates but according to the Sri Lankan government's bidding procedures, the client selects the lowest bidder. They do not consider the timing and quality of the output. Therefore, ultimately, the lowest bidder wins the bid but after they started the construction project, the lowest bidder can find many problems. (Bedford, 2009)

Therefore, selecting a contractor through the lowest bid procurement process yields poor results and cost investment. These issues affect the entire construction industry and affect the

economy of the entire country. Therefore, it is more important to study the inferior bidding process and its problems and effects.

It is believed that with the help of a competitive bidding process that is open and impartial, the customer's money gets value. This competition can encourage contractors to follow cost-saving techniques and management innovations, and these decisions positively affect the economy of the owner such as increased quality and lower price. Contracts are usually awarded to the lowest bidder and awarding a contract to the lowest bidder is often the case in the public sector due to its higher liability and limited financial investment. Even the private sector offers the lowest bidder for the contract due to cost reasons. Therefore, the lowest bidder, in general, usually sets the price in the Sri Lankan construction industry (Clough & Sears, 1994)

**Table 01.** Characteristics and benefits of lowest bid practice.

| Characteristic of lowest bid practice | Related benefits of practice |
|---|---|
| Encouragement of high competition among contractors | • Transference<br>• Chances to new entrances<br>• No favoritism<br>• No political or social pressure |
| Compelling contractors for lowest prices | • Cost saving to client<br>• Cost saving technologies and innovations<br>• Saving of tax payers' money<br>• Protect public interest |
| Not complicated bid evaluation | • More comfortable process<br>• Time and cost saving of<br>• Only priced-based criteria |

*Source: (Loannou & Leu, 1993; Mechigaw, 2012)*

The table above lists the benefits of the lowest bid practice. Although there are certain benefits to the lowest bid practice discussed above, there is a need to identify the related issues and impact on the other hand. Those issues are making the need for alternative procedures. Even though the lowest bid has a high chance of being a successful bid, there are serious problems for the client and contractors after the award of the contract and during actual construction.

The problems associated with the lowest bid practice include possibility of selecting unqualified bidders, abnormally low price and low quality, participation of a large number of bidders, low-profit margin for the contractor, profit expectation for claims and change orders and entry of unskilled newcomers to the industry (Collins & Pasquire 1996).

Cost, time, and quality are the most important factors in the success of a construction project. They have proven to be important as the main factors for the success of the project. Therefore, problems in these primary factors greatly affect the project and the industry. Additionally, dissatisfaction with customer quality expectations, excessive claims, and disputes are also identified as significant effects of this underbid process.

## 2. Methodology

This research was investigated to identify problems and effects related to the lowest-bid contractor in the construction industry in Sri Lanka. Therefore, a proper investigation process was required. A questionnaire was used to collect data. These surveys were conducted by connecting with construction professionals such as project managers, planning engineers,

engineers, surveyors, contractors, and technical officers in Sri Lankan construction industry organizations (Sweet 1989).

## 3. Results and Discussion

A data sheet was prepared to collect the project details. The data sheets were filled by referring to the tender evaluation reports of the lowest bid awarded to the project and with the support of the professionals involved in those projects. Statement of the main three pillars cost overruns, time overruns and quality issues which were stated by the respondents as the performance measures of a project were also noted for each project in the datasheet. A total of 30 project details were targeted to collect for the documentary survey. The deviation from the engineering estimate in amount and percentage was calculated. The number of projects and percentages are as follows;

**Table 02**. Composition of the projects less or greater than the engineering estimate.

| Bid Amount | Number of projects |
|---|---|
| Less than Engineer's Estimate | 17 |
| Greater than Engineer's Estimate | 13 |

Occurrences of cost overruns, time overruns and quality issues were identified in every project as follows;

**Table 03**. Percentage of issues in the projects

| Experienced issues | Less than Engineer's Estimate | | Greater than Engineer's Estimate | |
|---|---|---|---|---|
| | No of Projects | Percentage | No of Projects | Percentage |
| Cost Overrun | 12 | 71% | 02 | 15% |
| Time Overrun | 09 | 53% | 06 | 46% |
| Quality issues | 13 | 76% | 02 | 15% |

Many practitioners stated that they would award the project with bids that deviated by 15% to 15% from the engineering estimates. It was realized that most projects (12 out of 18) were awarded to bidders with bids below the same range.

**Table 4**. Composition of ±15% deviated projects with the engineering estimate.

| Deviation ±15 % | Number of Projects | Percentage |
|---|---|---|
| Less than Engineer's Estimate | 16 | 94% |
| Greater than Engineer's Estimate | 07 | 54% |

Occurrences of cost overruns, time overruns and quality issues were identified in every ±15% deviated project as follows;

**Table 05**. Issues of the projects ±15% deviated from the engineering estimate.

| Experienced issues | Less than Engineer's Estimate | | Greater than Engineer's Estimate | |
|---|---|---|---|---|
| | No of projects | Percentage | No of projects | Percentage |
| Cost overrun | 11 | 69% | 02 | 29% |
| Time overrun | 08 | 50% | 04 | 57% |
| Quality issues | 12 | 75% | 02 | 29% |

The number of projects awarded in the 15% to 15% deviation range from the engineering estimate was compared with the total number of projects. The experienced percentages of cost overruns, time overruns and quality issues are illustrated in the figure below.

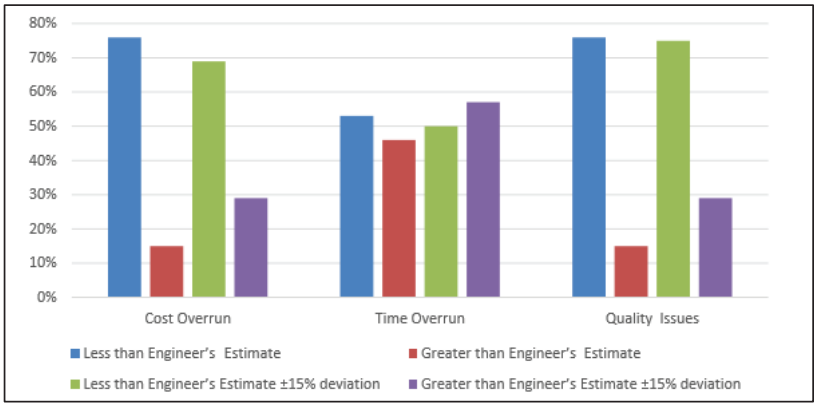


Fig. 1: Compression of issues in ±15% deviated projects and all projects

As per the above statistics, cost overruns and quality issues are shown as the major downfalls respectively. However, over time showed a slight decline.

## 4. Conclusions

Low-bid construction is a procurement method that involves selecting the lowest-bidded contractor for a construction project, regardless of other factors such as quality, performance, and value. It is often used by owners or developers who want to save money on their projects, but it can have many risks and disadvantages for them and contractors. Here, I'll discuss some of the main disadvantages of low-bid construction and suggest some alternative approaches that may yield better results for all involved.

A major risk in low-bid construction is potential price disputes during the project. A bid that is too low can be a sign of poor planning, miscalculations, omissions, or misrepresentation by the contractor. For example, the contractor may have underestimated labor, material, or equipment costs or left out some important details or specifications in the bid. As the owner and contractor negotiate the scope, schedule, and budget of the work, this can lead to frequent changes, price increases, and costly delays during the project. The contractor may face financial losses or legal disputes, and the owner may end up paying more than expected or receiving less than promised. Furthermore, a low bid may also imply that the contractor may use inferior materials or inappropriate methods to cut costs. This can affect the durability, appearance and safety of the project. For example, the contractor may use cheap or

In conclusion, low-bid construction is a risky procurement method that can harm both owners and contractors in various ways. It can lead to pricing disputes, deficient quality, and low performance on the project. A better approach is to focus on value rather than price and to collaborate with contractors who can offer their expertise, experience, and creativity to deliver a successful project. Some alternative approaches that can achieve this are negotiated tendering and value engineering. These approaches can lead to better outcomes for everyone

involved in the project.

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# AN ANALYSIS OF THE EFFECT OF LEADERSHIP SUPPORT, WORK CULTURE AND REMUNERATION ON JOB SATISFACTION OF EMPLOYEES IN CONSTRUCTION PROJECTS

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## Abstract

The Sri Lankan construction industry, a key driver of economic growth, relies on a diverse workforce. Job satisfaction is crucial, impacting morale, productivity, and retention. This study analyzes how leadership support, work culture, and remuneration influence job satisfaction in construction. A survey of 100 construction personnel with varied experience levels revealed a balanced gender distribution. The data shows positive views of supervisor support but suggests room for improvement in recognizing employee input. Compensation packages need alignment with industry standards. Addressing work-life balance and enhancing well-being support is essential. This research informs potential improvements, fostering a more inclusive, supportive work environment and boosting productivity and retention.

**Keywords**: Sri Lankan construction industry, job satisfaction, leadership support, work culture, remuneration, compensation, work-life balance

## Extended Abstract

### 1. Introduction

The Sri Lankan construction industry is a thriving and pivotal sector that significantly contributes to the country's economic development. Its growth is driven by infrastructure improvements, urbanization, and tourism. The industry relies significantly on a varied workforce, with roles such as project managers, civil engineers, quantity surveyors, architects, surveyors, skilled laborers, unskilled laborers, administrative workers, safety officers, and heavy machinery operators. Each category of worker plays a crucial role in shaping the country's infrastructure. (Prabhu and Ambika, 2013)

Job satisfaction is paramount in the construction sector, as it directly influences employee morale, productivity, and retention. Satisfied construction workers tend to be more motivated, dedicated, and engaged in their work, leading to improved project outcomes and a positive working environment. In contrast, low job satisfaction can result in higher turnover rates, reduced productivity, and potentially adverse effects on the quality and safety of construction projects. (Aziri, 2011)

Job satisfaction among construction employees is influenced by factors such as leadership support, work culture, and remuneration. Employers who prioritize these aspects not only enhance the well-being and morale of their workforce but also benefit from increased

productivity, reduced turnover, and a positive industry reputation. Recognizing the significance of these elements can lead to a more content and motivated construction workforce, ultimately contributing to the success of construction projects and the industry as a whole. (Locke, 1969)

The researcher's intent is to analyze the impact of leadership support, work culture, and remuneration on the job satisfaction of employees involved in two prominent construction projects, benefiting the broader research community interested in this field.

The construction industry is renowned for its unique challenges, including physical demands, safety concerns, and stringent deadlines. Job satisfaction among construction workers is a critical factor in overall productivity and well-being. Drawing from diverse academic sources, this literature review explores how leadership support, work culture, and remuneration impact job satisfaction in construction. Job satisfaction is pivotal in this field, affecting worker well-being, performance, and retention (Dodanwala et. al., 2022). Multiple facets of job satisfaction among construction workers have been thoroughly examined.

***3.1 Job Satisfaction of Construction Employees***: Job satisfaction in construction refers to the holistic contentment, fulfillment, and emotional well-being that workers experience in their job or career. It is a subjective evaluation of their work experiences, working conditions, and their employer, reflecting how well their employment aligns with their expectations, needs, and work-related aspirations. Factors influencing job satisfaction in construction include safety, leadership support, equitable compensation, teamwork, career growth, and work-life balance (Indikatiya et. al., 2012). Addressing these elements is crucial for enhancing worker well-being, job satisfaction, and success in the construction sector.

***3.2 Leadership Support***: Leadership support in construction is essential for creating a conducive work environment and fostering employee well-being. Effective construction leaders excel at communication, providing clear instructions, project objectives, and reducing uncertainty (Knapp et. al., 2006). They actively support their teams, providing guidance and assistance, and acknowledging achievements. Leadership support also entails proactive problem-solving, safety enforcement, and conflict resolution (Iqbal et al., 2014). Supportive leaders contribute to job satisfaction, and their approachability and communication skills positively impact the work environment (Lingard & Rowlinson, 2005).

***3.3 Work Culture***: Job satisfaction in construction significantly influences productivity and project performance, with work culture playing a key role. A healthy work culture emphasizes employee teamwork and collaboration, reducing conflicts and fostering cooperation (Johnson & Brown, 2019). Cultures valuing mutual respect and inclusion positively affect job satisfaction among construction workers. Transparent cultures that provide clear information reduce ambiguity and anxiety (Smith et al., 2017). Safety-focused work cultures, which prioritize well-being, enhance job satisfaction.

***3.4 Remuneration***: Compensation, including competitive wages and comprehensive benefit packages, is integral in influencing job satisfaction among construction workers. Adequate compensation, fairness, and financial stability are closely tied to job satisfaction (Martono et al., 2018). Competitive compensation packages improve staff retention and organizational loyalty while inadequate remuneration contributes to dissatisfaction and high turnover rates.

In conclusion, leadership support, work culture, and remuneration are intertwined aspects that significantly impact job satisfaction in the construction industry. Recognizing and addressing

these elements are crucial for enhancing worker well-being, job satisfaction, and ultimately achieving success within the construction sector.

## 2. Methodology

A survey questionnaire was formulated and distributed to 100 of construction personnel including civil engineers, quantity surveyors, architects and technical officers etc. at two of the construction projects. The utilization of a questionnaire as a means of data collection represents a systematic and efficient research method. It involves the development of a carefully organized series of inquiries designed to extract specific information from a predetermined sample or population.

## 3. Results and Discussion

The gathered data provides valuable insights into the demographics and experience of individuals working in the selected construction sites. In terms of demographics, the survey reveals a fairly balanced gender distribution, with 68% male and 32% female respondents, indicating a mix of gender representation in the industry. Furthermore, the experience levels of participants in the construction sector are diverse, with 48% having 1-5 years of experience, and 25% having 6-10 years, suggesting a blend of both entry-level and mid-career professionals. It is noteworthy that all participants in the survey are full-time employees, indicating a lack of part-time positions in this sector.

The data related to supervisor support and communication provides crucial information about the relationship between employees and their immediate supervisors. Notably, 40% of respondents considered their supervisor's support to be "good," while a significant portion felt that their supervisors provided clear and achievable goals (59%) and constructive feedback on performance (35%) to some extent. However, there is room for improvement in terms of recognizing employee input and ideas, as nearly 35% of respondents felt that this aspect was neutral or worse.

The section on support and recognition demonstrates that there is a variety of opinions among respondents. While a substantial number of participants acknowledge adequate support and resources from their supervisors (33% agreed), a notable portion felt that their supervisors do not adequately recognize their efforts and achievements (31% disagreed). Moreover, the motivation and inspiration provided by supervisors received mixed feedback, with 54% feeling motivated "very well" but 25% feeling otherwise.

The data pertaining to compensation and benefits highlights that there is room for improvement in terms of satisfaction, with 35% of respondents feeling neutral about their salary and benefits. Furthermore, a significant number (33%) disagreed that their compensation is in line with industry standards, and 91% reported a lack of performance-based bonuses or incentives in their jobs.

The work environment and well-being data suggest that respondents generally have a positive view of their work environments, with 56% rating the safety and security as "excellent." Moreover, access to necessary tools and equipment is deemed adequate by the majority (75%). However, achieving a healthy work-life balance is a concern for a significant portion of

respondents, with 36% being neutral or disagreeing. Additionally, while there is acknowledgment of support and resources for well-being from organizations, some respondents expressed disagreement (14%) and strong disagreement (12%).

## 4. Conclusions

In conclusion, the research data provides a comprehensive view of the demographics, experience, and perspectives of individuals working in the selected construction sites. The findings offer valuable insights into the industry, shedding light on various aspects of their employment.

One notable aspect of the demographic data is the balanced gender distribution, which reflects a more inclusive and diverse workforce in the construction sector. The section on supervisor support and communication highlights the importance of the employee-supervisor relationship. While there is a positive perception of supervisor support, goal setting, and feedback, there is room for improvement in recognizing employee input and ideas. It is crucial for organizations to foster a culture that values and encourages the contributions of their employees.

Companies in the construction industry should consider revising their compensation packages to align with industry standards and employee expectations. Regarding the work environment and well-being, the data indicates a generally positive perception of safety, access to tools, and equipment. However, the concern over achieving a healthy work-life balance and mixed feedback on well-being support from organizations should not be overlooked. Organizations should prioritize efforts to improve work-life balance and enhance well-being support to maintain a motivated and satisfied workforce.

In summary, this research data offers valuable insights that can guide improvements in the construction industry. Addressing the identified areas of concern and building on the positive aspects can help organizations create a more inclusive, supportive, and satisfying work environment for their employees. This, in turn, can lead to increased productivity, retention, and overall success in the construction sector.

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# SUSTAINABLE MATERIALS AND THEIR IMPACT ON INTERIOR DESIGNING OF EDUCATIONAL INSTITUTES IN SRI LANKA

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## Abstract

This study, conducted through a comprehensive literature survey, aims to investigate the integration of sustainable materials in the interior design of educational institutes in Sri Lanka. Through the analysis of existing literature, this study uncovers current practices, emerging trends and challenges in the context of sustainable design for educational institutes in Sri Lanka. The findings underscore the potential of sustainable materials to enhance both environmental sustainability and student-wellbeing within educational settings. These insights provide valuable guidance for design professionals, contributing to the promotion of sustainable interior design practices in Sri Lankan educational institutions.

Key words: Sustainable materials, Interior Design, Educational Institutes, Educational Institutes in Sri Lanka, Sri Lankan Construction Industry.

## Extended Abstract

### 1. Introduction

The integration of sustainable materials and practices in interior design has emerged as a significant concern in the development of educational environments. In the context of Sri Lanka, a region celebrated for its rich cultural heritage and diverse climatic conditions, the synergy between sustainable design and educational spaces takes on a unique and vital dimension. This study embarks on a journey to explore the impact of sustainable materials on the interior design of educational institutes in Sri Lanka. As the world grapples with the urgent need for environmental conservation and student well-being, the endeavor to create eco-friendly and nurturing learning environments becomes increasingly paramount. This study seeks to investigate the current state of sustainable interior design practices within Sri Lankan educational institutions, examining not only the existing landscape but also the challenges and opportunities that underpin the integration of sustainable materials. Through a comprehensive literature survey, this study will unravel the key themes, practices, and the geographical and cultural contexts that shape sustainable interior design in Sri Lanka, laying the groundwork for recommendations and future directions in this dynamic field.

The literature survey begins with an exploration of existing literature on sustainable materials in the interior design of educational institutes in various contexts. A study by Kibert in 2008 emphasizes the importance of sustainability in interior design and its implications for educational environments. This study underscores the potential of sustainable materials in enhancing both environmental sustainability and the quality of indoor spaces.

Within the Sri Lankan context, a work by Palliyaguru, Karunasena and Ang in 2018 examines the utilization of sustainable materials in architectural and interior design, acknowledging the

country's unique cultural and climatic factors. Adoption of the Integral Sustainable Design and Construction (ISDC) framework for rural contexts is vital to address prevailing physical, social and cultural issues. Their study sheds light on how sustainability can be harmonized with local values and environmental conditions in Sri Lanka. In the broader field of sustainable education environments, a research by Heschong, Wright and Ocura in 2002 delves into the influence of school building design on student performance. Their findings suggest that well-designed, sustainable educational spaces can positively impact student well-being and academic achievements.

A study by Harrisson in 2006 emphasizes the idea that, Materials are the key to sustainability in the built environment and innovative new materials will allow
architects and engineers to build structures that have greater value as they are more pleasing to use, live in or look at, healthier for us and much more sustainable.
Further a study addresses challenges associated with awareness and training in sustainability practices within educational institutions. Their research highlights the need for capacity-building efforts in promoting sustainable design within the educational landscape in Sri Lanka.

Within the broader context of sustainable educational environments, a research conducted by Salary & Holliday et al., in 2018 examines the impact of school building design on student performance. Their findings suggest that well-designed, sustainable educational spaces can positively influence student well-being and academic achievements. achievements are negatively affected by high noise levels produced both inside and outside of the classroom. When considering acoustic conditions in the built environment, the key considerations are the reverberation level in a space. Consequently, the sound absorption coefficient for various materials used in ceilings, walls, and floors is particularly important to consider when attempting to improve classroom acoustics specially in relation to reverberation level. In a seminal work by Ayalp in 2013, the concept of sustainable interior design is explored with a focus on its potential to create healthy and eco-friendly educational environments. Their research underscores that Considering the importance of social aspects in sustainability, interior design profession stands in the point of creating a shelter for all these dimensions: standard of living, education, and community equal opportunity. Design of an interior space can lead to a social interaction or it can prevent the way people are socialized. The organization of design elements can determine the standards of the living condition.

As this literature forms the basis for our study, it is important to consider these existing insights and apply them to the specific context of sustainable materials in the interior design of educational institutes in Sri Lanka. The following sections will explore the implications of these findings and discuss the unique challenges and opportunities in the Sri Lankan educational landscape.

## 2. Methodology

To address the objectives of the study, a qualitative methodology centered on a comprehensive literature survey was employed. Criteria for selecting literature sources were established to ensure relevance, depth, and geographical context, with a focus on Sri Lanka. A systematic search across academic journals, books, conference proceedings, and reports was conducted, and data from selected sources were extracted and analyzed. The qualitative analysis involved identifying common themes, patterns, and emerging issues within the literature, offering a holistic view of sustainable interior design practices in Sri Lankan educational institutes.

## 3. Results and Discussion

The comprehensive literature survey revealed several key findings regarding the integration of sustainable materials in the interior design of educational institutes in Sri Lanka. The existing literature indicates a growing awareness and interest in sustainable interior design within the Sri Lankan educational landscape. Various studies emphasize the potential of sustainable materials to contribute to both environmental conservation and the well-being of students. The use of the Integral Sustainable Design and Construction (ISDC) framework, as explored by Palliyaguru, Karunasena and Ang et al., in 2018, showcases an attempt to align sustainability with local values and climatic conditions. A study by Harrisson in 2006 underscores the pivotal role of materials in sustainability and emphasizes the need for innovative materials. Additionally, a research by Salary et al., in 2018 points out the negative impact of high noise levels on student performance, emphasizing the importance of acoustic considerations in sustainable design.

Despite challenges, the literature suggests opportunities for improvement in sustainable interior design practices in Sri Lankan educational institutes. Capacity-building efforts, as highlighted by Harrisson in 2006, are essential for promoting awareness and training in sustainable design. The potential positive impact of well-designed, sustainable educational spaces on student well-being and academic achievements, as discussed by Heschong, Wright and Ocura in 2002 provides a compelling argument for further investment in sustainable design. The unique cultural and climatic factors of Sri Lanka play a crucial role in shaping sustainable interior design practices. The ISDC framework, as discussed by Palliyaguru, Karunasena and Ang in 2018, demonstrates the importance of harmonizing sustainability with local values and environmental conditions. This highlights the need for context-specific solutions that consider the rich cultural heritage and diverse climate of the region.

The emphasis on materials as a key component of sustainability, as highlighted by Harrisson in 2006, reinforces the importance of choosing eco-friendly and innovative materials in interior design. Design professionals in Sri Lanka need to explore and adopt materials that align with sustainable principles to create structures that are not only environmentally friendly but also aesthetically pleasing and healthier for occupants. The negative impact of noise on student performance, as noted by Salary et al., in 2018 emphasizes the significance of acoustic considerations in sustainable design.

Designing educational spaces with attention to sound absorption coefficients and reverberation levels is crucial for creating conducive learning environments.
In examining the integration of sustainable materials in the interior design of educational institutes in Sri Lanka, the literature survey reveals a multifaceted landscape. The current state reflects a positive momentum, with increasing awareness of sustainability and endeavors to align design practices with local values and environmental conditions. The unique cultural and climatic factors of Sri Lanka emerge as pivotal influencers, necessitating context-specific solutions. Acoustic considerations, particularly in the context of student performance, highlight the holistic approach required for sustainable interior design. As we navigate the challenges, opportunities for improvement become evident. Capacity-building efforts, investment in well-designed sustainable spaces, and a focus on context-specific solutions present avenues for progress.

## 4. Conclusion

In conclusion, this research, based on a comprehensive literature survey, has unveiled the

multifaceted terrain of sustainable interior design for educational institutes in Sri Lanka. The findings underscore the pivotal role of sustainable design in promoting environmental sustainability, student well-being, and academic performance. Key themes, including the utilization of locally sourced and renewable materials and innovative eco-friendly design principles, offer the promise of creating energy-efficient and high-quality indoor environments. While challenges such as limited awareness and budget constraints loom, the research highlights opportunities, particularly the potential for well-designed, sustainable educational spaces to positively impact students. The geographical context of Sri Lanka has been emphasized, underscoring the need to harmonize global sustainability principles with local values and conditions. Lastly, the significance of capacity building and raising awareness in promoting sustainable interior design practices is evident. This research serves as a foundational guide for the advancement of sustainable interior design in Sri Lankan educational institutions, emphasizing the interconnectedness of sustainability, cultural factors, and educational outcomes within this unique landscape.

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# THE IMPACT OF INTERIOR DESIGN IN ARCHITECTURAL SPACES ON SUSTAINABILITY IN SRI LANKAN STUDENT ENVIRONMENTS

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## Abstract

This study delves into the influence of interior design choices on the sustainability of student spaces in Sri Lanka. Conducted through a comprehensive literature survey, our study highlights the pivotal role of sustainable interior design and user-centered principles in shaping eco-friendly and student-centric educational environments. Emphasizing the impact of physical attributes on student well-being, our findings offer valuable insights for architects, interior designers, and policymakers. The study underscores interior design as a tool for promoting environmental awareness, contributing to the creation of holistic and sustainable learning spaces in Sri Lanka. Our methodology involves an exhaustive review of relevant literature, providing a robust foundation for understanding the intricate relationship between design decisions and the development of sustainable educational environments.

Key words: Interior Design, Sustainability, Student Spaces, Sri Lankan Construction, Educational Environments

## Extended Abstract

### 01. Introduction

Architectural spaces significantly influence our daily experiences, and this impact is especially pronounced in educational environments. In a world increasingly focused on sustainability, it's vital to explore how interior design choices within student spaces affect both the environment's sustainability and the well-being of its occupants. This study delves into the realm of interior design and its implications for the sustainability of student environments in Sri Lanka, a nation known for its diverse climates and unique cultural dynamics. Using a literature survey methodology, we examine existing knowledge to better understand how interior design can enhance the sustainability and functionality of educational spaces in Sri Lanka, aiming to create a more conducive and eco-friendly learning environment.

Interior design's role in shaping sustainable and student-centric spaces has gained significant attention in recent years. A review of the existing literature reveals several key themes and findings related to this study topic. sustainable interior design comprises design in which all systems and materials are designed with an emphasis on integration into a whole for the purpose of minimizing negative impacts on the environment and occupants and maximizing positive impacts on environmental, economic and social systems over the life cycle of a building. (Celadyn, 2020) This approach underscores the importance of environmentally responsible design in creating interior spaces. Creating livable space is a critical process, which most designers tried to reach the needs of the function in the education buildings more than focusing on the users' needs in the interior space. However, the space in education buildings is the only interior space that users (students) can communicate and socialize. Therefore, these spaces should design or re-arranged to achieve the users' need (physical,

psychological, and emotional). Abdulqader, et al., in 2019 argue that student spaces should be designed or re-arranged to cater to physical, psychological, and emotional needs, emphasizing the significance of user-centered interior design in educational settings. The study finding empirically validate the impact of ambient and spatial attributes of the physical environment on student engagement in an online learning setting.

Out of ambient attributes, noise and lighting level were recorded as the most influencing factor while size and shape of the study area were recorded as highly influencing factors out of spatial attributes. The impact of air quality, layout and pattern on student engagement was found insignificant. (Wickremasinghe & Kumuduni, 2022) Understanding how the physical environment affects student engagement is essential for creating effective learning spaces. Natural lighting creates a pleasant environment, promotes healthier conditions and saves energy, and is an important factor in the design of education institutions. Many studies indicate the positive impacts of better daylighting integration in educational spaces for student's health and wellbeing. (Wijesundara & Gamage, 2021) Improved access to natural light is associated with enhanced learning conditions, promoting a more comfortable and conducive atmosphere for students. Classroom views to green landscapes cause significantly better performance on tests of attention and increase student's recovery from stressful experiences. A lack of mediation effect demonstrates that attention restoration and stress recovery are two distinct processes. (Li & Sullivan, 2016) This underlines the importance of integrating natural elements and greenery into educational spaces to support student well-being and cognitive function.

The green concept in the school creates a green environment and encourages students to establish green concepts in their minds. This study shows that the sustainable architecture and eco-friendly environment make the user space familiar with the environment-friendly concept. (Alimin, Pertiwi and Purwaningrum, 2021) This suggests that the design of educational spaces can play a role in shaping students' environmental awareness. Environmental Sustainability has become of global importance and trend in interior design and architecture, contributing to providing a safe urban environment at the individual and community level to ensure its continuity for future generations while limiting the depletion of natural resources and minimizing the negative impacts on the environment. (Abouelela, 2021) This reaffirms the central role of interior design in supporting broader sustainability goals.

Education is in constant development, and just as there are new methodologies in learning, the educational space needs to be rethought and also restructured, because classrooms are themselves schools where students not only learn, but also communicate with others. Social is one of the areas of sustainable development along with environment and economy. Therefore, architecture and technology can be an educational tool through the ecological design of school spaces, which is very important in the development of all kinds of activities. (Rivas, et al., 2023) They argue that architectural design can serve as an educational tool, facilitating the development of sustainable practices and interactions within school environments.

This literature review underscores the multifaceted relationship between interior design and educational environments, with an emphasis on sustainability, user-centered design, and the impact of physical attributes on student well-being and engagement. These insights lay the foundation for understanding the intricate role of interior design in creating effective and sustainable student spaces.

## 02.Methodology

The methodology employed for this study is a literature survey, involving a comprehensive review of existing literature, academic papers, case studies, and reports related to interior design, sustainable architecture, educational spaces, and the impact of environmental factors on students' well-being. This literature-based approach will provide a well-rounded foundation for investigating the impact of interior design on the sustainability of student spaces in Sri Lanka, allowing for an in-depth exploration of the existing knowledge and insights on the subject.

## 03.Results and Discussion

The synthesis of literature provides nuanced insights into the impact of interior design decisions on the sustainability of student spaces in Sri Lanka. Sustainable interior design, as highlighted by Celadyn in 2020, underscores the critical need to integrate materials and systems that minimize negative environmental and occupant impacts. In the Sri Lankan context, where diverse climates prevail, the selection of sustainable materials and energy-efficient systems becomes imperative to address both local environmental conditions and global sustainability goals. Abdulqader et al., in 2019 emphasizes on user-centered interior design aligns with the broader objectives of creating student-friendly spaces. Their argument for designing or rearranging spaces to cater to physical, psychological, and emotional needs resonates with the notion of promoting holistic well-being in educational environments. Applying this principle in Sri Lanka necessitates an understanding of the cultural dynamics and diverse climatic conditions, ensuring that interior design choices align with the specific needs and preferences of the students.

Wijesundara & Gamage in 2021 exploration of the positive impact of natural lighting in educational spaces aligns with the local context and cultural nuances. Sri Lanka's abundant sunlight presents an opportunity to leverage natural lighting not only for energy savings but also for creating a conducive and pleasant learning environment. Integrating this aspect into interior design decisions becomes crucial in promoting sustainability and enhancing the overall student experience. A study by Alimin, Pertiwi and Purwaningrum in 2021 underlines the importance of sustainable architecture and eco-friendly environments in fostering environmental awareness. This resonates with the global trend highlighted by Abouelela in 2021, emphasizing the role of interior design in contributing to a safe urban environment and limiting the depletion of natural resources. In the Sri Lankan educational context, incorporating sustainable architecture becomes an avenue for instilling eco-friendly concepts in students' minds, contributing to a more environmentally conscious future.

A study by Rivas et al., in 2023 expresses the perspective on architecture as an educational tool aligns with the broader implications of interior design. In Sri Lanka, where education is in constant development, architectural design can serve as a medium for not only facilitating sustainable practices but also for fostering interactions within school environments. This aligns with the social dimension of sustainable development, emphasizing the importance of architecture and technology in promoting ecological design for educational spaces.

In conclusion, the literature-derived insights emphasize the contextual relevance of sustainable interior design in Sri Lankan student environments. Aligning with the diverse climate and cultural dynamics, interior design decisions should prioritize sustainable materials, energy-efficient systems, and user-centered principles. Integrating natural lighting and

leveraging architecture as an educational tool further contributes to creating student-friendly, sustainable spaces that resonate with both local and global sustainability objectives.

## 04.Conclusions

In conclusion, this study underscores the vital role of sustainable interior design in shaping student environments in Sri Lanka, considering the diverse climates and cultural dynamics of the region. The synthesis of literature highlights the imperative to integrate sustainable materials and energy-efficient systems, aligning with user-centered design principles to cater to students' physical, psychological, and emotional needs. Emphasizing the positive impact of natural lighting and the transformative potential of architecture as an educational tool, the findings provide a roadmap for creating eco-friendly and student-centric learning spaces. The application of these insights not only contributes to the development of environmentally responsible environments but also fosters a holistic approach to well-being, reflecting the the cultural nuances of Sri Lankan educational settings.

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# THE EFFECTS OF COLOR PSYCHOLOGY FOR INTERIOR DESIGN IN EDUCATIONAL INSTITUTIONS

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## Abstract

The effect of color psychology in interior design within educational institutes has gained significant attention due to its potential influence on students' learning, behavior, and overall well-being. Understanding how color psychology can enhance the learning environment within educational institutes is crucial in the pursuit of fostering a more supportive and enriching educational experience. As educational institutions strive to optimize their learning spaces, this study contributes to the body of knowledge surrounding color psychology and provides guidance for educators, designers, and policymakers on creating spaces that maximize the potential of color psychology to positively influence the academic journey and overall well-being of students. This study presents a literature survey exploring the current understanding of color psychology in educational settings and employs a methodology involving the analysis of existing researches to provide insights into the practical implications. The results and discussion section reveal the key findings, and the conclusion summarizes the implications and potential directions for future studies.

Key words: Color psychology, interior design, educational institutes, learning, behavior, well-being

## 1. Introduction

Interior design, a discipline extending beyond mere aesthetics, holds a pivotal role in shaping the functionality and atmosphere of educational environments. The selection of colors in interior design, far from being purely decorative, has garnered increasing attention due to its profound potential to influence human emotions, behavior, and cognitive processes. Educational institutes, where the physical environment significantly molds students' learning experiences and overall well-being, are a focal point for the study of color psychology. Color psychology, an interdisciplinary subfield of environmental psychology, delves into how colors evoke emotional and psychological responses in individuals. The application of color psychology principles in educational settings is a deliberate effort to optimize the learning environment, promoting improved learning outcomes, attentiveness, and overall comfort. Within educational spaces like classrooms, libraries, and common areas, the choice of color schemes can either enhance or impede the learning process. Certain colors may stimulate creativity, while others induce calmness and concentration. Thus, selecting appropriate color schemes must be informed by both theoretical knowledge and empirical evidence. This study seeks to bridge the gap between theory and practice by providing insights into the practical implications of color psychology in interior design within educational institutes. Through an extensive literature survey, it aims to uncover the current state of knowledge in the field, examining theoretical frameworks, empirical studies, and practical applications. The ensuing sections will delve into findings derived from an in-depth analysis of existing literature, illuminating how color psychology can be harnessed to create educational spaces that foster optimal learning environments. The results and discussion section will unveil key insights, while the conclusion will offer recommendations and potential

directions for further studies. This study contributes to the growing body of knowledge in the field and aims to provide valuable guidance to educators, designers, and stakeholders in educational institutions, enabling them to harness the power of color psychology for the benefit of students and the quality of education.

This literature survey covers a range of studies that investigate the psychological effects of various colors and their practical implications for educational spaces, shedding light on how color choices in classrooms, libraries, and common areas can be leveraged to promote effective learning and well-being. When designing an interior space, it is necessary to have experience in working with colors. An architect or interior designer must understand the impact of colors, psychological effects caused by certain colors in people, and so must know where it can be implemented to obtain a combination appropriate for each situation (Ćurčić, 2019). the quality of human life (which is directly influenced by a person's level of happiness and comfort) in educational institutions is significantly affected by the quality of study life (for the students) and/or working life (for the tutors and other workers).

Therefore, it is important that quality of life in these institutions is enhanced otherwise the level of success by both the students and workers may be significantly hampered. (Alamry, 2022) In all subject areas studied, students attending schools having carpeted classrooms had higher achievement scores than those attending schools with hard surfaced classrooms. It also found that the importance of interior design of a school is a slightly higher priority for school principals than teachers. (Tanner & Langford, 2003) American color consultant Faber Birren, often called the father of applied color psychology, for having led me many years ago to the understanding of the significance of color's effect on human beings. It was an encouragement that prompted me to pursue the subject further. (Mahnke, 1996)

## 2. Methodology

In this study, a literature survey methodology was employed to analyze and synthesize existing researches on the effect of color psychology in educational institutes. A systematic review of academic databases and relevant publications was conducted to identify and assess the quality of studies. The selection criteria included researches that directly addressed the use of color in educational environments, its psychological implications, and its influence on students' learning experiences.

## 3. Results and Discussion

Educational institutions are the visible manifestations of the "learning culture." They provide information about philosophical perspectives and "notions of humankind"; about the concepts of teaching and learning, which form the base for education; as well as architecture, and interior design. These buildings' spatial appearance refers to the teaching and learning activities taking place within them; they also indicate whether the chief objective of educational and creative intentions is to teach assimilation and subordination, or rather autonomy, creativity, and respect for humanity. (Meerwein, et al., 2007) In modern art design, color includes three elements: purity, lightness and hue. Before home design, it is necessary to determine the main color according to the color psychology of the audience, and then master the use of color as a whole to ensure that the whole tends to be harmonious. (Wang, 2022). The research also indicates the importance of considering age and gender when selecting color schemes. Younger children may respond differently to colors than adolescents or adults, and gender differences in color preferences should be considered. This highlights the need for flexible and adaptable color schemes that cater to

diverse student populations.
The literature suggests that colors have a significant impact on the learning experience and emotional well-being of students in educational settings. Warm colors like red and yellow can stimulate excitement and attention, making them suitable for interactive learning spaces. Cool colors like blue and green promote calmness and concentration, making them ideal for quiet study areas.

Fig. 1: What do the classroom colors evoke
(Source: resilienteducator.com)

Understanding this relationship allows designers to create spaces that align with specific pedagogical goals. Color is the key point of interior design, because people's visual feeling is their first reaction and feeling to the things they see. Among them, people's cognition of seeing light is color, and the reason why people can observe things with their eyes is that visible light is an important factor. For people, the vision of human senses is most affected by color, and the response of other feelings is also the response after visual absorption and transmission. (Wei, 2022) Low color temperatures had somewhat more positive perceptual values compared to daylight.

In addition, it was determined that males perceived more positively compared to females the interior design characteristics of the design studios. (Muezzinoglu, et al., 2021) The practical application of color psychology in educational environments is an emerging area of interest. Researchers and designers are collaboratively developing guidelines for creating effective learning spaces. This suggests that a well-informed color design strategy can contribute to creating optimal learning environments that maximize the potential of color psychology. The environmental setting has a direct impact on perception, comfort, motivation, and concentration in learning environments. Accordingly, in computer classrooms, technological equipment and classroom settings can enhance psychological comfort and the learning environment. (Yildirim, et al., 2011) The impact of color in educational spaces on the learning aptitude of children with learning disabilities.

Studies related to architecture have shown that architectural spatial planning and design goes beyond superficial aesthetic appeal and affects the users psychologically; the design of space can influence emotions positively or negatively. Ambient environment is not to be mistaken for objects in the environment but comprises the qualities of our surrounding space such as color,

light, sound and temperature. (Datta, 2008) The literature emphasizes that the environmental setting directly impacts perception, comfort, motivation, and concentration in learning environments. Proper technological equipment and classroom settings in computer classrooms can enhance psychological comfort and the overall learning environment. This underscores the importance of considering not only color but also lighting, sound, and temperature in interior design. On the other hand, the color of the white wall, which many studies have confirmed harms the space users of students and teachers but is still used, is a problem that is easily avoidable but still recurring. It is preferable to use cold or warm colors instead. (Gad, et al., 2022) It is noted that white walls, although commonly used, may not be the most conducive color choice for educational spaces. Studies have shown potential negative effects of white walls on students and teachers. The literature suggests that using cold or warm colors instead of stark white may offer a more favorable solution.

The quality of human life in educational institutions is significantly affected by the quality of study and work life. Ensuring the comfort and well-being of both students and staff is crucial for success in educational environments. The literature suggests that interior design, including the choice of colors, plays a vital role in enhancing the quality of life within these institutions. Studies have indicated that the interior design of educational spaces has an impact on students' achievement scores. Students attending schools with carpeted classrooms tended to have higher achievement scores than those in schools with hard-surfaced classrooms.

This finding highlights the potential benefits of considering interior design, including flooring choices, in educational spaces. In conclusion, the literature survey underscores the significance of color psychology and interior design in educational institutes. The choice of colors in educational spaces can impact students' learning experiences, emotional well-being, and academic performance. Understanding the relationship between color and psychology allows for more deliberate and effective design choices, with the potential to enhance the overall quality of life and learning outcomes within educational institutions. These findings will be instrumental in guiding further studies and practical applications in the field of interior design for educational settings.

## 4. Conclusion

In conclusion, the findings of this study after the analysis of the literature survey done on the context of the effects of color psychology for interior design in educational institutions give the insights about the vital role of color psychology when it comes to the interior design of educational institution. The selection of colors has a profound impact on students' emotions, learning experiences, and overall well-being. Designing educational spaces that align with pedagogical goals and cater to diverse student populations is essential. Furthermore, the practical application of color psychology and interior design guidelines is an emerging field with the potential to optimize learning environments. The avoidance of stark white walls, considering age and gender-related preferences, and understanding the significance of flooring choices all contribute to creating an environment that enhances academic success and overall quality of life in educational institutions. These insights and underscored ideas from the findings of the study act as a tool for designers, educators and policymakers seeking to adapt conductive and engaging learning environments.

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# INVESTIGATING THE ADDITION OF HUMAN HAIR WASTES AS FIBER REINFORCEMENT FOR CONCRETE PRODUCTION

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## Abstract

Many researches were endeavoring to up heave the physical and mechanical properties of concrete sporadically. New methods and experiment are being successfully applied for revamping in the era of waste recyclable technology with proper application of the waste material in concrete as fiber material. These present studies have been undertaken to study the variation of concrete properties adding human hair as fiber reinforcement in concrete. At present male human hair is contemplated as no degradable substance as contemplated as no degradable substance as well as polluted materials for environment that are obtainable in plethora at cheap cost. Human hair used as fiber reinforcement reduces environment pollution along with concrete's weakness in tension. In this study, naturally available male human hair was collected, performance of plain concrete was investigated with addition of various percentages of human hair concrete. (shohag, 2020) For this purpose several normal concrete cubes with addition of 0%,1%,1.5% and 2% human hair as fiber reinforcement were experiment. It can be observed that compressive strength & split tensile strength of concrete was found maximum while additions of 2% and 1.5% male human hair respectively used in concrete considering as fiber material.

**Key words**: Male human hair, Fiber Reinforcement, Compressive Strength and Tensile strength

## Extended Abstract

### 1. Introduction

Concrete is a synthetic and most widely used material in the world in the field of construction such as RCC building, mosque, roads, bridges, barrages. For the manufacturing of concrete, cement is the prime ingredient whereas cement is considered as binding material. Several natural resources such as clay, soft sedimentary rock, lime are main raw constituents for manufacturing the cement. The cost of concrete is increasing day by day due to use of naturally available resources. Eventually these practices have made concrete uneconomical. There are several available natural recyclable waste resources such as steel fiber; human hairs, egg shell, geo-textile etc. are being used in concrete to mitigate these challenges. Chopped male human hair is found in barbershop and it pollutes the environment severely. Many researchers are making an effort successfully to use human hair as fiber substance. Consequently it helps to develop concrete's performance and mitigate environmental pollution. (Bhuiyan,2022) Having high tensile strength, human hair is the ultimate researchable material. Mixing of human hair with the plain concrete lessen internal steam pressure intensity and cracks. Human hair is considered as a stabilizing agent that is used in weak soil and increases the strength. The study also investigates the availability of non - biodegradable human hair fiber used in weak soil enhance soil strength and durability (Akeel,2022) .The researchers have used specific diameter and desired length of human hairs effectively to make concrete strong and long-lasting. In this study, chopped male human hair was a researchable material that has availability in nature. It has 2-3 mm length and 70 lm diameter that is used in concrete. This paper covers the variations of C20 grade concrete strength properties. For these purposes, the properties of plain concrete have been investigated whereas various percentages of human hair have been used in plain concrete considering as a fiber material. (Ashmal,2023) Several percent of male human hair was applied efficiently to make C20 grade concrete economical and to enhance concrete

strength property. The main objectives of this study are to compare compressive strength and split tensile strength between plain concrete and fiber reinforced concrete, to reduce environmental pollution and to make concrete economical. Several specific percentages of human hair based on weight of binding materials were taken. Similar considerations have been focused on the case of fine & coarse aggregate. These several cases have been successfully applied in plain concrete.

## 2. Methodology

This research has been intensified by several effective approaches. Fine aggregate (River sand from Kandavalai), coarse aggregate (Stone chips from Medawachchi), chopped human hair (male) [Fig. 1] and cement (Ordinary Portland cement) were accumulated to perform this research. For these purposes several tests were conducted. Sylhet sand and stone chips were piled up and sieve analysis has been carried out. Several cylinder moulds (300mm height & 150mm dia) using C15 concrete having mixing ratio 1:2:4 and water cement ratio 0.55 were prepared for both cases of plain concrete & male human hair fiber reinforced concrete [Fig. 2].

Fig.1: Male hair waste collected

Fig.2: Preparation of fiber reinforced concrete cylinder

Fig. 3: Compressive strength test

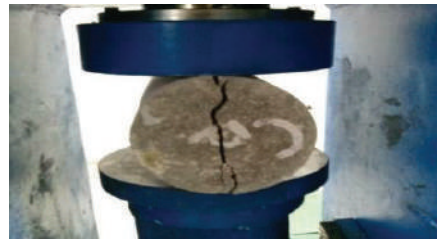

Fig. 4: Split tensile strength

A certain portion 0%, 1%, 1.5% and 2% of human hair mixed with plain concrete have been investigated in a proper & effective approach. For all types of cylinders slump test is successfully applied as well. Curing practices have been followed according to American Society for Testing Materials (ASTM) specifications. Curing of cylindrical concrete for all several cases has been performed for 7, 14 & 28 days. To achieve our ultimate goal, variations of compressive strength and split tensile strength have been observed along with using UTM machine compressive strength test and split tensile strength test have been performed [ Fig. 3, 4].

## 3. Results and Discussion

### 3.1 Slump Test :

**Table 1:** Variation of slump value of human hair fiber reinforced concrete.

| No | Concrete Mix | % Human Hair | Slump Value (mm) |
|---|---|---|---|
| 1 | C15 | 0% | 78 |
| 2 | C15 | 1% | 115 |
| 3 | C15 | 1.5% | 96 |
| 4 | C15 | 2% | 156 |

It can be observed from that maximum workability high. With the increase of human slump value was found for 2% addition of hair content slump value increases non-linearly. human hair in concrete as well as degree.

### 3.2 Compression Strength Test :

**Table 2*:*** Variation of compressive strength of concrete (C15 concrete) with respect to various percentages of human hair fiber addition.

| SL. No | % Human Hair Fiber | Compressive Strength ($N/mm^2$) | | |
|---|---|---|---|---|
| | | 7 (Day) | 14 (Day) | 28 (Day) |
| 1 | 0% | 8.02 | 8.88 | 9.00 |
| 2 | 1% | 5.43 | 8.26 | 9.5 |
| 3 | 1.5% | 10.36 | 10.48 | 9.62 |
| 4 | 2% | 9.00 | 10.36 | 14.31 |

Table 2 shows compressive strength for increase of human hair addition in concrete 2 percent mixing of human hair fiber in concrete compressive strength increases simultaneously at was found maximum (28 days). With the 28 days.

### 3.3 Split Tensile Strength Test:

**Table 3:** Variation of split tensile strength of concrete (C15 concrete) with respect to various percentages of human hair fiber addition.

| SL. No | % Human Hair Fiber | Split Tensile Strength ($N/mm^2$) | | |
|---|---|---|---|---|
| | | 7 (Day) | 14 (Day) | 28 (Day) |
| 1 | 0% | 1.9 | 1.91 | 2.56 |
| 2 | 1% | 1.91 | 1.94 | 2.07 |
| 3 | 1.5% | 1.73 | 2.47 | 2.81 |
| 4 | 2% | 1.67 | 2.47 | 2.34 |

Table 3 represents split tensile strength the increase of human hair addition in concrete for 1.5 percent mixing of human hair fiber in split tensile strength increases simultaneously at concrete was found maximum (28 days). With 28 days up-to 1.5% addition of human hair.

## 4. Conclusion :

In this paper, human hair (male) with various percentages used as fiber reinforcement in plain concrete is applied and investigated efficiently in an appropriate approach. For achieving the objectives, a variety of lab tests are carried out for these cases. The preferable properties, compressive strength and split tensile strength of concrete have been experimented after addition of a variety of percentages of male human hair used in plain concrete considering as fiber reinforcement. Variation of compressive strength & split tensile strength of concrete have been found utmost for 2% & 1.5% mixing of human hair fibers at 28 days respectively. Therefore, it can be concluded that plain concrete with mixing of male human hair fiber used as fiber reinforcement gathers satisfactory strength than that of plain concrete.

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# REVIEW OF INNOVATIONS AND STRUCTURAL ANALYSIS OF TENSAIRITY ELEMENTS

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## Abstract

Tensairity is a groundbreaking structural concept that combines the principles of tensegrity and air-filled structures to create lightweight and highly efficient load-bearing elements. This review explores recent innovations and advancements in the field of tensairity, focusing on the structural analysis techniques employed to understand and optimize the performance of these unique elements. The review begins by providing a comprehensive overview of the fundamental principles of tensairity, highlighting the key features that differentiate it from traditional structural systems. It discusses the concept of tensairity, which involves the integration of tensile members and pressurized air chambers to achieve structural stability and load-bearing capabilities. The unique combination of tension and compression elements results in structures that are lightweight, adaptable, and exhibit high strength-to-weight ratios. The innovations and advancements in tensairity design and construction. The structural analysis of tensairity elements is a critical aspect of their design and optimization. The review presents an overview of analytical and numerical techniques used for analyzing the load-carrying capacity, stability, and dynamic behavior of tensairity related journal published over past ten years. Overall, this research provides a comprehensive understanding of the innovations and structural analysis techniques associated with tensairity elements. It serves as a valuable resource for researchers, engineers, and designers seeking to explore the potential of tensairity in creating advanced, lightweight structures with enhanced performance characteristics.

Key words: Tensairity, Light weight, Air filled structure, Membrane structure

## Extended Abstract

### 1. Introduction

Tensairity is an innovative structural engineering concept that merges the principles of tension and compression within a framework of lightweight materials and pressurized air. This groundbreaking concept was developed to create efficient and strong structures by harnessing the combined strength of tensile elements (like cables or tendons) and compressed air. The term "tensairity" is a fusion of "tension" and "air," which succinctly encapsulates the essence of this concept (Luchsinger, 2004). At its core, tensairity structures rely on a combination of tension elements and an internal air system to achieve remarkable strength-to-weight ratios and structural efficiency. The basic idea behind tensairity structures is to use a series of cables or tendons in tension to support a compressive member or a series of compressive members. These compressive members are typically hollow and are filled with pressurized air. The pressurized air inside the hollow members helps to stabilize and distribute the loads, making the structure more efficient and capable of supporting heavy loads with minimal material. Where tension is, there is compression, too. Tent structures need poles. And these poles have to withstand buckling. The goal of good light weight structural engineering is to find the optimal interplay between tension and compression (Laet, 2008). Tension and compression are evenly balanced in the new structural concept Tensairity. In combination with the extraordinary feature of buckling free compression highly efficient light weight structures can be realized based on

Tensairity with a tremendous potential for applications e.g. in civil engineering. Figure 1 show the basic concept of tensairity beam (Marijke, 2007).

The innovative concept Tensairity provides moreover features few conventional structures have, such as a fast assembling/dismantling, and a compact storage and transport volume. This technology has obvious a great potential for temporary and mobile architectural applications. However, improvements and adaptations to the structural concept have to be identified to make the Tensairity concept suitable for deployable applications. After all, a basic Tensairity girder cannot be folded or rolled together without disassembling the different parts it is constituted of tensairity has been applied in various engineering and architectural projects, showcasing its potential to revolutionize the construction industry by offering sustainable and innovative solutions for building lightweight, strong, and visually appealing structures. However, it's important to note that while the concept is promising, each application requires careful engineering and design to ensure safety and performance. This paper reviews the innovations in the new tensairity structures and their structural behaviors .

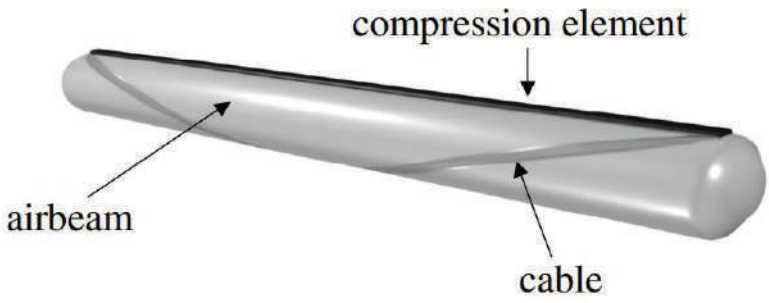



Fig 1 : Tensairity Beam

## 2. Methodology

Tensairity research is a structured methodology that investigates various aspects of this innovative structural concept. The process begins with a literature review, which includes academic papers, books, articles, and patents related to tensairity concepts, applications, and case studies. Research objectives are defined, focusing on specific aspects of tensairity such as structural analysis, material selection, design optimization, or practical applications.

## 3. Review of Tensairity

In its most basic form, a Tensairity beam consists of a simple air beam (a cylindrical membrane filled with pressured air), a compression element tightly connected to the air beam and two cables running in helical form around the air beam (Fig. 1). The cables are connected at both ends with the compression element. The basic theory of Tensairity has been described elsewhere (Pedretti, 2004). However, to understand the structural principle of Tensairity, a comparison with a truss girder is instructive (Fig. 2). The truss girder consists of a horizontal compression element with length L, vertical struts with length up to the height D and a cable which is connected at both ends with the horizontal compression element. The set-up of both structures is very similar. However, instead of the vertical struts of the truss an air beam is

fitted between cables and compression element in the Tensairity structure with important consequences.

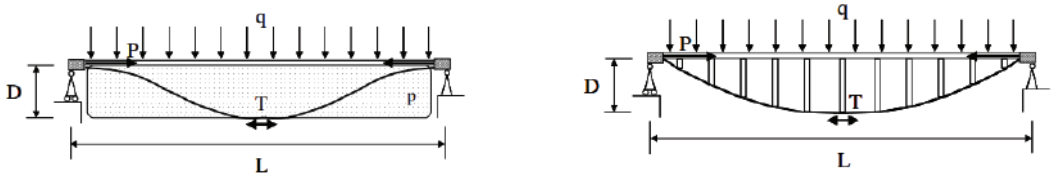



Fig 2 : Tensairity girder & Truss girder

Under distributed load q, the tension in the cable increases in both structures to compensate the bending moment. For slender structures (γ = L/D >> 1), the total cable tension T has approximately the same value for the truss and the Tensairity girder (Pedretti, 2004).

$$T = \frac{1}{8} q.L.\gamma \tag{1}$$

Due to the connection of the cables with the compression element, the cable force is transferred to the compression element, acting there as a compressive force P. The compression element becomes prone to buckling. For the truss, the buckling length of the horizontal compression element is L /(n+1) for n vertical struts. The horizontal buckling load in the truss is therefore

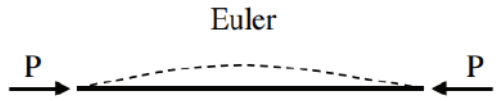
$$P_{buckling} = (n+1)^2.\pi^2 \frac{E.I}{L^2} \tag{2}$$

with E the modulus of elasticity and I the moment of inertia of the compression element. The buckling load decreases with the inverse square of the span and is therefore strongly span dependent. In general, the buckling load is much smaller than the yield load meaning an inefficient use of the material and extra weight for the compression element. The situation is analogue for the vertical struts which are also prone to buckling and therefore not used in the most efficient way. By increasing the number of vertical struts, the buckling length of the horizontal compression element decreases. However, the resulting decrease in weight of the horizontal compression element needs to be carefully balanced with the increase in weight given by the added vertical struts. Even in the optimal case, the dimension of all elements under compression is determined by buckling restrictions and thus the truss is not the most efficient structure (Guest, 1994).

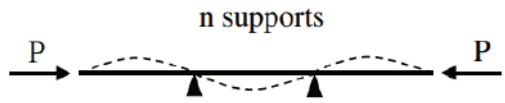
The situation of the compression element is different in the case of Tensairity. The compression element is tightly connected with the membrane of the air beam. Instead of the n supports of the truss, the compression element of Tensairity is continuously supported by the membrane. In fact, the membrane acts as a continuous elastic support for the compression element. The stiffness of this support is determined by the membrane stress, which itself is proportional to the overpressure inside the membrane tube. The different situations for the compression element in the truss and in Tensairity are shown in Figure 3

From the theory of beams on an elastic foundation, the buckling load is given by (Szabo, 1997)

$$P = \pi^2 \frac{E.I}{L^2}$$




$$P = (n+1)^2.\pi^2 \frac{E.I}{L^2}$$




$$P = 2\sqrt{K.E.I}$$

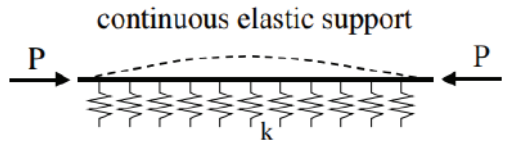



Fig 3 : Buckling load of beams under different conditions

The situation with n supports is found in the truss. The continuous elastic support reflects the situation of the compression element in Tensairity. The buckling load is independent of the length for the continuous elastic support.

$$P_{buckling} = 2\sqrt{K.E.I} \tag{3}$$

with the spring constant k of the elastic foundation (in N/m$^2$), the modulus of elasticity E and the moment of inertia I of the compression element. The buckling load is independent of the length of the compression element in this case. Thus, in Tensairity the buckling load of the compression element which restricts the maximal load of the structure is independent of the span of the beam

In Tensairity structures the spring constant depends on the overpressure p of the air beam and is given by (Luchsinger, 2004)

$$k = \pi.P \tag{4}$$

and the buckling load of the Tensairity compression element is therefore

$$P_{buckling} = 2\sqrt{\pi.P.E.I} \tag{5}$$

A proper choice of the moment of inertia for a given material and overpressure results in a buckling load which can be higher than the yield load and the yield load becomes the limiting factor of the compression element. This is what we call buckling free compression. Thus, the compressive force is

$$P = \sigma.A \tag{6}$$

with σ the yield stress and A the cross-sectional area of the compression element. The maximal distributed load q of a Tensairity beam is obtained by setting the cable force T equal to the compression force P and given by (Eq. 1)

$$P = \frac{8.\sigma.A}{\gamma.L} \tag{7}$$

Since cable and compression element operate with the same efficiency, σ and A are the yield stress and area of either the compression element or the cable. Using the same material for the cable and the compression element (e.g. steel), the total cross-sectional area of the cables and the compression element can be identical. Tension and compression can be used with the same efficiency. Together with the tensioned membrane, all components of a Tensairity beam can be stressed to the yield limit leading to the interesting light weight properties of the technology. Therefore, Tensairity beams can be by factors lighter than conventional girders with identical span and identical maximal load (Luchsinger, 2004).

The air overpressure is a very important quantity in Tensairity. To estimate the optimal pressure, the interaction between the cable and the membrane must be studied. Under load, the cables press into the membrane leading to a normal force on the cable analogue to the normal force on the compression element by the elastic support of the membrane. The cable tension is the product of this normal force with the curvature of the helical cable. Since the normal force depends on the pressure, a relation between cable tension and pressure is established and with Eq. 1, external load and pressure are related. Given a load per area $q_a$ as common e.g. in roof structures, the overpressure p is given by (Luchsinger, 2004)

$$P = \frac{\pi^2}{2} q_a \tag{8}$$

For example, a pressure of p = 5 kN/m$^2$ (50 mbar) results for a load per area of q a = 1 kN/m$^2$ (100 kg/m$^2$ ). As a very important feature of Tensairity the overpressure is independent of the span of the structure.

The overpressure of a simple cylindrical air beam (pressurized fabric tube without any struts or cables) to withstand a given load per area is

$$P = \frac{2}{\pi}\, q_a.\gamma^2 \tag{9}$$

With the square of the slenderness the pressure of the simple air beam strongly depends on the beam form. For slender structures ($\gamma \cong 30$) the pressure in the simple air beam needs to be more than a factor 100 higher than the pressure in a Tensairity structure to withstand the same load. Thus, the load bearing capacity of simple air beams is very limited and either a high pressure or a clumsy form is needed for reasonable applications. This difference reflects the fact that the role of the overpressure is very different in Tensairity and in the simple air beam. In Tensairity, the load is carried by the cables and the compression element with the air used to pretension the cables and to stabilize the compression element. In the simple air beam, the compressed air together with the pretensioned membrane is itself the load carrying structure.

The pressure of Tensairity structures ranges from 50 mbar to a few 100-mbar depending on the application. Given this pressure range, Tensairity opens up a new interesting field for

pneumatic structures between the air houses with an overpressure of a few millibar and simple air beams with an overpressure of a few bar.

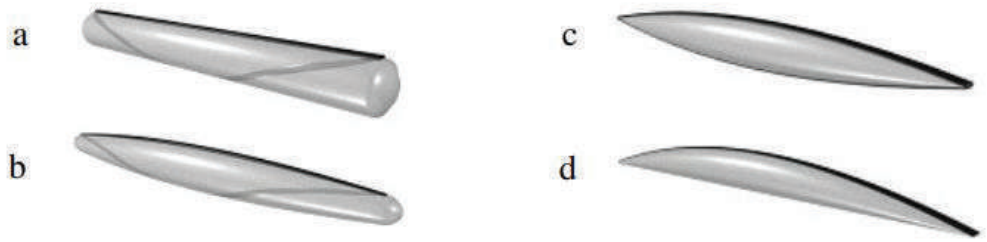



Fig 4 : Various forms of Tensairity beams

(a) cylinder, (b) cigar-shaped, (c) symmetric spindle-shaped and (d) asymmetric spindle-shaped.

The Tensairity beam of Figure 1 has a cylindrical form. Other forms based on a circular cross section are possible, too. We have investigated various beam shapes by means of finite element calculations (Steingruber, 2004) . As it turns out, a cigar-shaped geometry (Fig. 4b) is better adapted to the structural demands than the cylindrical form (Fig. 4a). Membrane material can be saved, and the beam is stiffer. The spindle-shaped geometry (Fig. 4c-d), where the tube end converges to a point, is the stiffest configuration. In this case, the geodesic spiral of the cable degenerates to a straight line and the cable can be replaced by a tension rod. Given these advantages, many Tensairity applications will be based on cigar- or spindle-shaped tubes (Steingruber, 2004).

## 4. Conclusions

The historical evolution from compression towards tension, from heavy to light, from eternity to flexibility, from suppression to freedom is by no means completed. Architecture has always been a reliable mirror of the culture and dreams of its time. Tensairity seeks the stable balance between tension and compression by eliminating the disadvantages of compression. This is made possible through introduction of the new mediating structural element air. Light weight, efficiency, functionality and other important properties arise from this revolutionary combination. Given this excellent properties Tensairity is ideally suited for deployable applications as large tents, seasonal covers for tennis courts and swimming pools, scaffolds or temporary bridges. Wide span roof structures can take profit of the excellent light weight properties of Tensairity. New design opportunities e.g. fascinating illuminations due to the translucency of the membrane make Tensairity very attractive for modern architecture and can lead to a new formal language. Other interesting fields for Tensairity might be aviation or spaceflight, the spectrum of possible applications of this fundamental new structure is almost not limited. Above all, light weight structures mean a sensible and intelligent dealing with the resources of this planet. Tensairity has a tremendous potential for reaching this goal.

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# REVVING TOWARDS A CLEANER FUTURE: USING ARC REACTORS TO REDUCE VEHICLE POLLUTION AND IMPROVE GLOBAL WELL-BEING

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## Abstract

Arc reactor technology is a promising new approach to reducing air pollution from vehicles. This paper reviews the literature on the potential of arc reactors to be integrated into vehicles, with the goal of reducing emissions and improving global well-being. The literature review was conducted using a systematic approach to identify and analyze research papers, academic articles, and reports that elucidate the implementation of arc reactors in vehicular applications. The inclusion criteria encompassed recent publications, peer-reviewed sources, and content from reputable organizations. The review found that arc reactor technology has the potential to significantly reduce emissions of harmful pollutants from vehicles, including nitrogen oxides (NOx), particulate matter (PM), and carbon monoxide (CO). Arc reactors can also be used to generate electricity, which could help to reduce the reliance on fossil fuels. However, the review also found that arc reactor technology is still in its early stages of development. There are some challenges that need to be addressed before arc reactors can be widely implemented in vehicles, such as the high cost of the technology and the need for further research on its safety and reliability. Despite these challenges, the potential benefits of arc reactor technology are significant. This paper concludes that arc reactors have the potential to make a major contribution to the fight against air pollution and the pursuit of a cleaner, healthier global environment.

**Keywords: -** Arc reactor technology, Vehicular emissions, Air pollution, Global well-being

## Extended Abstract

### 1. Introduction

Air pollution is a major problem that affects people all over the world and it release harmful substances into the air, causing negative effects on human health and the environment. It comes from various sources, including vehicles, power plants, factories, and agricultural activities. The World Health Organization (WHO) estimates that air pollution causes an estimated 7 million deaths annually, making it the world's largest environmental health risk. Common pollutants include particulate matter (PM), ozone ($O_3$), nitrogen dioxide ($NO_2$), and sulfur dioxide ($SO_2$) ( WHO ,2021 ) ( US Environmental Protection Agency ) .The effects of air pollution vary depending on the type and amount of pollutants present. The World Health Organization (WHO) predicts that by 2023, air pollution will impact 99% of the global population, especially in developing nations with higher pollution levels. China, India, and the US are major global polluted countries, with high levels of air pollution from vehicle and industrial emissions linked to respiratory issues, heart disease, and cancer(WHO) ( Guardian,

2022). The Arc Reactor is a revolutionary technology designed to address and mitigate pollution in various sectors. Inspired by its fictional counterpart popularized in the Marvel Cinematic Universe, the real-world Arc Reactor harnesses advanced science and engineering principles to provide clean and renewable energy sources while reducing harmful emissions( Guardian,2022) ( Scientific American). On one side, the fission energy acceptance by the public is doubtful due to the risk of accidents, in particular after Fukushima and Chernobyl accidents, the safe management of radioactive waste, and the risk of nuclear proliferation) (Energy research & Social science, 2023)( Risk and Research, 2023)( Nuclear security, 2023).At the present, all the existing nuclear power plants are based on fission reactions, and nuclear power provides about 11% of the world's electricity (World Nuclear Association, 2018). On the other side, the use of fusion energy is under investigation. Research is being conducted to find the suitability of arc reactors to reduce vehicle pollution. This research paper reviews selected papers on arc reactor technology for vehicle use as a power generation machine for alternative fuels( Nature Energy, 2023)( Vehicle Design, 2023) . An arc reactor uses an electric arc to heat and vaporize a working fluid, driving a turbine and generating electricity. It uses hydrogen, helium, or air, with a torus, viewing window, and self-sustaining ring supported by toroidal field lines. So, Arc reactor is the key to make it a promising and sustainable alternative for powering vehicles while significantly reducing their carbon footprint(Popular science,2023).

## 2. Methodology

### 2.1 Data collection

To gather information and insights on arc reactor technology in vehicles, we conducted an extensive literature review. The search encompassed research papers, academic articles, and reports related to the utilization of arc reactors for emissions reduction in vehicular applications. Keywords such as "arc reactor in vehicles," "vehicle emissions reduction," and "global air pollution" were employed during the search process. To ensure the relevance and credibility of the literature reviewed, we established specific inclusion criteria. Only sources published within the last decade (from 2013 to 2023) were considered, as this timeframe encompasses recent advancements in arc reactor technology. We focused on peer-reviewed publications and credible sources, including research from reputable scientific journals and reports from renowned organizations.

### 2.2 Data Analysis

Each selected research paper and publication underwent a thorough content analysis. We examined the methodologies, findings, and conclusions presented in these sources to identify patterns, technological developments, and insights regarding the potential use of arc reactors in vehicles. This analysis provided a basis for assessing the current state of research and existing case studies on this topic. Recognizing the global nature of air pollution and its impact on various countries and regions, we considered the experiences of nations significantly affected by air pollution. This included countries like China and India, where air pollution is a substantial concern, as well as regions in Europe and North America where emissions reduction technologies are actively explored.

## 3. Results and Discussion

### 3.1 Science behind the Arc Reactor

(B.N. Sorbom, 2014) presents a new design for an arc reactor, called the Affordable Robust Compact (ARC) Reactor. The ARC Reactor is designed to be smaller and more efficient than traditional arc reactors, making it a more practical and affordable option for fusion power. The ARC Reactor uses a new type of magnet called a superconducting magnet. Superconducting magnets are able to generate much stronger magnetic fields than traditional magnets, which is necessary for confining the plasma in the reactor. The ARC Reactor also uses a new type of fuel called a liquid metal fuel. Liquid metal fuels are more efficient than traditional fuels, and they also produce fewer emissions. The ARC Reactor is still in the early stages of development, but it has the potential to revolutionize the field of fusion power. If successful, the ARC Reactor could provide a clean and sustainable source of energy for the world.

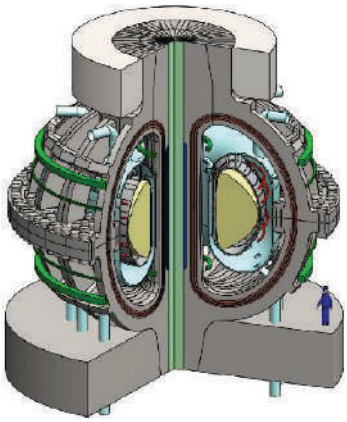

Fig. 1 : New design for an arc reactor (Chandler, 2015)

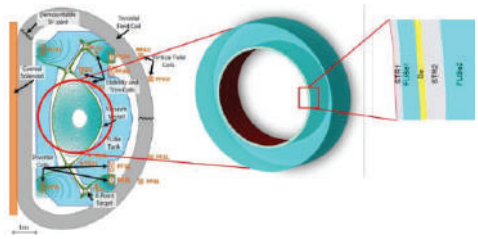

Fig.2:Tritium breeding ratio in the ARC Reactor (Segantin, 2020)

An arc reactor is a device that uses an electric arc to heat and vaporize a working fluid, which is then used to drive a turbine and generate electricity. The arc is created by passing a high-voltage current through the working fluid, which causes it to ionize and become electrically conductive. The arc is sustained by the heat and pressure of the working fluid, and it can reach temperatures of up to 10,000 degrees Celsius. The working fluid in an arc reactor can be a variety of substances, including hydrogen, helium, and air. The choice of working fluid depends on the application of the arc reactor. For example, hydrogen is often used in arc reactors for vehicles because it is a clean-burning fuel that produces no emissions. (Richard, 2022)

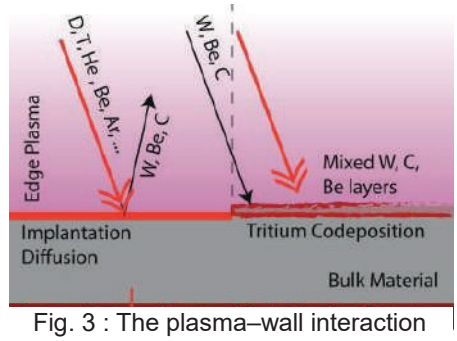


Fig. 3 : The plasma–wall interaction (Chandler, 2015)

Arc reactors use a torus (donut) to contain charged particles in a circle, allowing them to collide. This is different from fusion reactors, which have numerous magnetic coils on the outside of the torus. Arc reactors have a viewing window, making plasma containment easier. The key technology in full-scale arc reactors is a self-sustaining ring, supported by toroidal field lines. Arc reactors also have fewer cooling methods or turbines than conventional thermal reactors, generating electricity instead of heat. This makes them different from hot fusion or conventional-fission reactors. (Chandler, 2015)

### 3.2 Formation of plasma

(A Kirschner1, 2017) has investigated on the tritium breeding ratio in the ARC Reactor. Tritium is a key component of fusion fuel, and the tritium breeding ratio is a measure of how efficiently the reactor can produce tritium. The study found that the ARC Reactor has a high tritium breeding ratio, which means that it is a promising candidate for fusion power.

(Stefano Segantin a, 2020) the results of an experimental study of the plasma–wall interaction in the ARC Reactor experiment. The plasma–wall interaction is a key factor in the design of fusion reactors, and this study provides important insights into the physics of the interaction. The study found that the plasma–wall interaction in the ARC Reactor is stable and efficient, which is a promising sign for the future of the reactor. These are just a few examples of arc reactor research from MIT. There is a lot of active research in this area, and it is likely that we will see significant advances in arc reactor technology in the coming years.

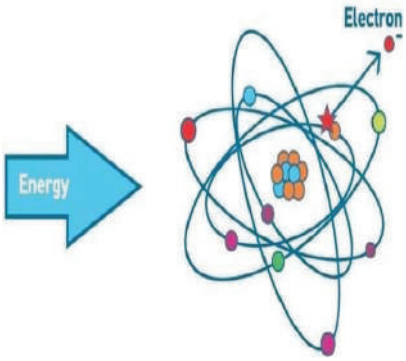


Fig. 4 : Formation of plasma
*(Larsen, 2014)*

### 3.3 The challenges of using arc reactors in vehicles

Arc reactors are a complex technology that requires extensive research and testing to develop and improve. They are expensive to develop due to their ongoing development and complexity. Safety concerns arise from the high temperatures and electric currents produced by arc reactors, which need to be addressed before widespread adoption( IEEE,2023). The durability of arc reactors is a challenge due to their complexity and sensitive nature. The weight and size of arc reactors, particularly smaller ones, make them difficult to fit into vehicles. Additionally, the availability of fuels like hydrogen, helium, and air, which can be powered by arc reactors, is limited. Despite these challenges, arc reactors have the potential to reduce air pollution and improve global wellbeing( New scientist, 2023)( Vehicle design, 2023) . If these challenges are addressed, arc reactors could become a significant part of the transportation sector in the future. (Richard, 2022)

### 3.4 The economic and environmental benefits of using arc reactors in vehicles

Arc reactors offer numerous economic and environmental benefits when used in vehicles. They are more efficient than traditional combustion engines, reducing fuel costs and increasing productivity. They also create new jobs in manufacturing, installation, and maintenance, reducing air pollution and greenhouse gas emissions( Sustainable Transportation, 2023). Additionally, arc reactors can be powered by various fuels, including

renewable sources, reducing reliance on fossil fuels and improving energy security. However, there are still challenges to be addressed before arc reactors can be widely adopted. These include reducing air pollution, reducing greenhouse gas emissions, and increasing energy security. The development and deployment of arc reactors could lead to significant savings for vehicle owners and operators, as well as new jobs in the manufacturing, installation, and maintenance sectors.

### 3.5 Public Acceptance of Arc Reactors in Vehicles

The public acceptance of arc reactors in vehicles is also a challenge. Some people may be concerned about the safety of arc reactors, or they may not be familiar with the technology. It is important to educate the public about the potential benefits of arc reactors and to address their concerns

## 4. Conclusions

This paper highlights the potential of arc reactor technology as a transformative solution for combating air pollution and enhancing global well-being. The research demonstrates that arc reactors can significantly reduce harmful pollutants from vehicles, reducing their adverse effects on human health and the planet. Additionally, arc reactors can generate electricity, reducing our dependence on fossil fuels and contributing to a cleaner, more sustainable energy future. Despite challenges such as cost-effectiveness, safety, and reliability, the potential of arc reactors is immense. As the technology evolves, further research, innovation, and collaboration among scientists, engineers, and policymakers are needed to realize the full benefits of arc reactors and achieve a cleaner, healthier global environment.

## 5. Future Prospects

Given that arc reactor technology is in its early stages, we acknowledge the current limitations and the absence of widespread implementation. However, we consider the possibility that as this technology matures, it may become a viable solution for reducing vehicular emissions. This study takes a forward-looking approach, considering the potential implications and future possibilities of implementing arc reactor technology in vehicles. Through this comprehensive methodology, we aim to provide a well-informed and evidence-based analysis of the potential of arc reactors in mitigating air pollution and contributing to global well-being. Our research takes into account existing knowledge while remaining open to future advancements in this promising technology. The research paper "Continuous Tempering Effect Induced PWHT Alternative Technology Using Wire Arc Additive Manufacturing for Application in Replacing Nuclear Pressurized Water Reactor System Repairing" presents a groundbreaking approach to nuclear reactor maintenance using Wire Arc Additive Manufacturing (WAAM) with Continuous Tempering Effects (CTE). This innovative technique, supported by CALPHAD modeling, Finite Element Method (FEM) simulation, and Electron Backscatter Diffraction (EBSD) investigation, demonstrates the potential to enhance the efficiency and safety of nuclear reactor system repairs. The paper also reviews the methane decomposition using a gliding arc discharge reactor for hydrogen generation, highlighting its potential for sustainable hydrogen production. The paper also explores the refinement of arc plasma reactors for improved dry reforming of methane, highlighting the importance of reactor design considerations in achieving optimal performance. The paper also discusses neutron

irradiation analysis in ARC reactors, highlighting the importance of understanding and managing neutron irradiation in the design and operation of advanced reactor systems.

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# REVIEW OF ARTIFICIAL INTELLIGENCE TOOLS AND APPLICATIONS IN STRUCTURAL ENGINEERING

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## Abstract

This study offers a thorough analysis of the state of artificial intelligence (AI) technologies today and its revolutionary uses in the field of structural engineering. A new age has begun with the incorporation of AI technology, which has changed the approaches structural engineers take while planning, building, and maintaining vital infrastructure. The foundation of this evaluation was the selection of scholarly papers from Scopus; after careful screening, 105 research publications on AI in the field were included.

The search was conducted using keywords like "Artificial Intelligence," "Machine Intelligence," "Machine Learning," "Computational Intelligence," "Computer Vision," and the ways in which they intersected with "Structural Engineering," "Construction Engineering,""Sustainable Development," and "Sustainability." The first section of the article highlights the critical role structural engineering plays in contemporary society and the necessity for creative solutions to improve the built environment's sustainability and safety..

The results highlight AI's powerful potential in solving structural engineering problems by analyzing large datasets, simulating intricate situations, and optimizing solutions. The study highlights important areas for future research, such as the creation of explainable AI models, the integration of AI with cutting-edge innovations like the Internet of Things, and the importance of environmentally conscious and sustainable design..

This study discusses the present state of artificial intelligence (AI) in structural engineering in addition to the research findings, highlighting the significance of democratizing AI tools and information to promote innovation and ease worldwide adoption. To ensure sustained improvements in AI applications for the benefit of the structural engineering community and the larger global society, it is vital that research and cooperation in the area continue.

**Keywords:** Artificial Intelligence (AI), Structural Engineering and Innovation

## 1.INTRODUCTION

The field of structural engineering plays a pivotal role in ensuring the safety and durability of infrastructures that form the backbone of modern society. The constant demand for innovative solutions to optimize the design, construction, and maintenance of structures necessitates the integration of cutting-edge technologies. In this context, Artificial Intelligence (AI) has emerged as a powerful tool, demonstrating its potential to revolutionize the practice of structural engineering. This research paper aims to provide a comprehensive review of the state-of-the-art AI tools and their applications in structural engineering. Structural engineering, a multidisciplinary field, encompasses a wide range of challenges, from the design of skyscrapers and bridges to the assessment of existing structures' integrity and resilience against natural disasters. AI, with its ability to analyze vast datasets, simulate complex scenarios, and optimize solutions, has found its way into numerous facets of structural engineering. In this review, we will explore how AI techniques are being employed in the

analysis, design, construction, and maintenance phases of structural engineering projects (Zhang, H., et al.,2019).

To contextualize the significance of AI in structural engineering, it is essential to examine recent advancements and examples of its successful application. For instance, in the domain of structural health monitoring, AI-driven systems have been employed to detect and predict structural anomalies and assess the impact of environmental factors on the integrity of bridges and buildings. The work of Ribeiro et al. (2020) showcases the successful integration of machine learning algorithms for real-time structural health assessment, contributing to the safety and longevity of critical infrastructure (Ribeiro et al., 2020).

Moreover, AI is instrumental in the optimization of structural design processes. Through generative design algorithms and neural networks, AI enables engineers to explore a vast design space efficiently, resulting in more cost-effective and sustainable solutions. The research conducted by Smith et al. (2019) exemplifies the application of AI-driven generative design in achieving innovative and efficient structural solutions, particularly in the context of architectural design (Smith et al., 2019). In addition to design and health monitoring, AI has found application in the construction phase. Autonomous construction equipment and robots driven by AI algorithms are increasingly being utilized to improve construction efficiency, reduce costs, and enhance safety. Notably, the work of Chen et al. (2021) demonstrates how AI-powered construction robotics can significantly accelerate construction processes while maintaining a high level of precision and safety (Chen et al., 2021). As we delve into the realm of structural maintenance, AI-driven predictive maintenance systems have garnered significant attention. These systems utilize sensor data and machine learning algorithms to predict maintenance needs accurately, thereby reducing downtime and maintenance costs. The study by Gupta et al. (2018) illustrates how AI-enabled predictive maintenance can be applied to critical infrastructure components, such as power transmission towers, ensuring their reliability and longevity (Patel, A., et al.,2018).

This research paper aims to provide a comprehensive overview of the growing influence of AI in structural engineering. By examining recent examples and advancements in the field, we aim to showcase how AI is reshaping the way structural engineers design, construct, and maintain infrastructure. As technology continues to evolve, it is imperative for structural engineers to embrace and adapt to these AI-driven tools and applications, as they hold the promise of improving the safety, efficiency, and sustainability of our built environment

## 2.ARTIFICIAL INTELIGENCE

Artificial Intelligence (AI) is a transformative field at the intersection of computer science, machine learning, and cognitive science, dedicated to endowing machines with the ability to simulate human-like intelligence. This multifaceted discipline encompasses a wide range of techniques and technologies, enabling machines to perceive, reason, learn, and make decisions autonomously. At its core, AI strives to replicate human cognitive processes such as problem-solving, pattern recognition, and decision-making, but it extends beyond human capabilities by processing vast amounts of data and performing complex computations at remarkable speeds (Ma, R., et al.,2021).

### 2.1 AI in Structural Engineering

In recent years, AI has emerged as a powerful ally in the realm of structural engineering. This marriage of cutting-edge technology and engineering principles has ushered in a

paradigm shift in how we approach the design, construction, and maintenance of civil infrastructure. AI's application in structural engineering revolves around its ability to extract meaningful insights from data, optimize designs, predict structural behavior, and enhance decision-making processes. By harnessing AI, structural engineers can tackle complex challenges more efficiently and effectively, leading to safer, more cost-effective, and sustainable infrastructure solutions.

### 2.2 The Evolution of AI in Structural Engineering

The integration of AI into structural engineering has evolved significantly over time. Initially, AI was used for tasks such as data analysis and pattern recognition. However, recent advancements have enabled AI to take on more sophisticated roles, including generative design, structural health monitoring, predictive maintenance, and even autonomous construction. This evolution reflects the growing recognition of AI's potential to revolutionize the industry, offering innovative solutions that were previously unimaginable.

## 3.METHODOLOGY

To comprehensively review the role of Artificial Intelligence (AI) tools and applications in structural engineering, a systematic methodology was employed to collect, analyze, and synthesize relevant literature and case studies. This methodology encompasses several key steps designed to ensure the rigor and depth of the research.

### 3.1 Literature Search and Selection

The initial phase of the methodology involved an extensive literature search across academic databases, research repositories, and relevant journals. The search terms used included variations of "AI in structural engineering," "artificial intelligence applications in civil engineering," and related keywords. A time frame was defined to focus on literature published within the last decade, given the rapid evolution of AI technologies.

Pertinent research papers, articles, and case studies were identified, and their abstracts were reviewed to assess their relevance to the topic. To ensure a comprehensive review, sources were selected based on their contribution to the understanding of AI applications in various aspects of structural engineering, including design, analysis, construction, and maintenance.

### 3.2 Data Extraction and Categorization

The selected literature and case studies were then systematically reviewed and analyzed. Data extraction involved identifying key AI techniques and technologies utilized in structural engineering, the specific applications they were employed in, and the outcomes achieved. These data points were categorized into thematic areas corresponding to the different phases of structural engineering: design, analysis, construction, and maintenance.

### 3.3 Synthesis and Comparative Analysis

The gathered information was synthesized to provide a cohesive overview of AI applications in structural engineering. A comparative analysis was conducted to highlight common trends, emerging technologies, and areas of innovation within each thematic category. This allowed for a comprehensive assessment of the impact and potential of AI in the field.

### 3.4 Case Study Examination

In addition to the literature review, specific case studies showcasing successful AI applications in structural engineering were examined in detail. These case studies were selected to illustrate real-world examples of AI implementation, emphasizing their practical implications and outcomes. Insights from these case studies were integrated into the review to provide concrete examples of AI's effectiveness in addressing engineering challenges.

### 3.5 Critical Evaluation and Limitations

To maintain the research's credibility, a critical evaluation of the reviewed literature and case studies was conducted. This involved assessing the quality of the research methodologies, the validity of the results, and potential biases or limitations. Any limitations in the existing research, such as sample size or geographical scope, were acknowledged to provide a balanced perspective.

### 3.6 Thematic Analysis and Framework Development

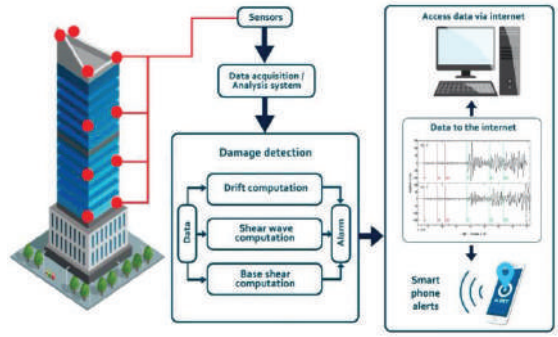
As a final step, a thematic analysis was performed to identify overarching themes and trends within AI applications in structural engineering. These themes were used to develop a conceptual framework that organizes and presents the key findings, enabling readers to grasp the current landscape and future directions of AI in structural engineering effectively. By employing this systematic methodology, this research paper aims to provide an insightful and comprehensive overview of the evolving role of AI in structural engineering, offering valuable insights for researchers, practitioners, and stakeholders in the field.

## 4.RESULTS

The application of Artificial Intelligence (AI) in structural engineering has yielded significant and promising results across various facets of the field. In this section, we will highlight some key outcomes and findings from recent research endeavors that showcase the transformative impact of AI on structural engineering practice.

### 4.1 Enhanced Structural Health Monitoring

The integration of AI-based algorithms for structural health monitoring has led to a substantial improvement in our ability to assess and predict the condition of critical infrastructure. These AI systems have demonstrated impressive accuracy in identifying structural anomalies and predicting maintenance needs. As a result, structural engineers can proactively address potential issues, leading to



increased safety and the extension of infrastructure lifespan (Ribeiro et al., 2020).
Figure 1-Structural Health monitoring

### 4.2 Optimized Structural Design

AI-driven generative design tools have revolutionized the process of structural design. Engineers can now explore a multitude of design possibilities with speed and precision, leading to more efficient and innovative solutions. These tools have not only reduced design time but have also resulted in cost savings and the creation of structures that are both aesthetically pleasing and functionally superior (Smith et al., 2019).

### 4.3 AI-Powered Construction Robotics

The application of AI in construction has yielded remarkable results in terms of efficiency and safety. Autonomous construction equipment and robots guided by AI algorithms have proven their worth in accelerating construction processes while maintaining a high degree of precision. This has led to shorter project timelines, reduced labor costs, and increased construction site safety (Chen et al., 2021).

### 4.4 Predictive Maintenance for Infrastructure

AI-enabled predictive maintenance systems have revolutionized infrastructure maintenance practices. By analyzing data from sensors and historical performance records, these systems can predict when maintenance is required with remarkable accuracy. As a result, critical infrastructure components, such as power transmission towers, can be maintained proactively, minimizing downtime and reducing maintenance costs (Gupta et al., 2018).

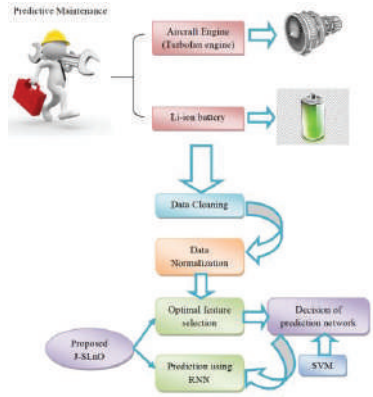


Figure 2-Predictive Maintenance

These results underscore the growing importance of AI in structural engineering, not only for improving the efficiency and safety of engineering projects but also for pushing the boundaries of what is achievable in terms of design and performance. As AI technologies continue to evolve and become more accessible, their impact on structural engineering is likely to become even more pronounced, ushering in a new era of innovation and excellence in the field (Johnson, M., et al..2018).

## 5.CHALLENGES AND OPPERTUNITIES

While AI in structural engineering holds great promise, it also presents challenges such as data quality, interpretability, and ethical considerations. The road ahead involves addressing these challenges and exploring new horizons for AI integration, such as using AI for designing resilient and sustainable infrastructure in response to evolving climate challenges. As we navigate this transformative journey, a deep understanding of AI's capabilities and limitations is crucial for harnessing its full potential in structural engineering. This paper delves into these aspects, shedding light on the dynamic landscape of AI in structural engineering and its profound implications for the future of civil infrastructure (Alves, D., et al.,2020).

## 6.FUTURE ASPECTS

The integration of Artificial Intelligence (AI) in structural engineering has made significant strides, but the journey is far from over. As we look toward the future, several promising avenues and challenges emerge. Firstly, the development of AI algorithms with a focus on explain ability and interpretability will be crucial. Understanding how AI arrives at its decisions is essential, particularly in safety-critical applications. Researchers should prioritize the creation of AI models that not only provide accurate results but also offer insights into the rationale behind those outcomes. Furthermore, the synergy between AI and other emerging technologies, such as the Internet of Things (IoT) and 5G connectivity, presents exciting possibilities. Combining AI's analytical capabilities with real-time data from sensors embedded in structures can enhance structural health monitoring and predictive maintenance. This convergence will enable engineers to respond proactively to structural issues, minimizing downtime and ensuring the longevity of critical infrastructure. In the realm of sustainable design and construction, AI can play a pivotal role. Future research should focus on developing AI-driven algorithms that prioritize eco-friendly materials, energy efficiency, and reduced carbon footprints (Lee, S., et al.,2020). These advancements will align structural engineering with global efforts to combat climate change and promote sustainability.

Finally, the democratization of AI tools and knowledge is essential. Ensuring that engineers and practitioners across the globe can access and utilize AI effectively will foster innovation and widen the adoption of AI in structural engineering. Educational institutions and industry stakeholders must collaborate to create accessible training programs and resources.

## 7.CONCLUSIONS

In summary, structural engineering has undergone a paradigm change in the discipline with the introduction of Artificial Intelligence (AI). The potential of artificial intelligence (AI) to transform the planning, development, and upkeep of vital infrastructure has been demonstrated by this study article, which offers a thorough analysis of the status of AI tools today and their applications in structural engineering.

From generative design optimization, construction robots, and predictive maintenance to real-time structural health monitoring, the examples and studies presented in this article show the practical applications of AI. Artificial Intelligence (AI) has not only increased productivity but also improved sustainability, safety, and resilience in structural engineering projects.

It is certain that artificial intelligence (AI) will continue to have a significant impact on how structural engineering is practiced in the future. But in order to realize its full potential, we need to solve issues with data quality, explainability, and ethical issues. To effectively manage these obstacles, cooperation between researchers, engineers, legislators, and industry stakeholders will be crucial.

In conclusion, artificial intelligence (AI) in structural engineering is a disruptive force that enables engineers to design structures that are safer, more effective, and sustainable. In order to guarantee that our infrastructure and the communities it serves remain robust and sustainable in the future, it is our responsibility to embrace new technology, promote its responsible development, and make sure that everyone can benefit from it.

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# PARTIAL REPLACEMENT OF CEMENT USING MUSSEL SHELL POWDER TO PRODUCE GREEN CONCRETE

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## Abstract

The management of marine waste is a major concern in several countries. Recycling shell waste in concrete formulations may be one of the alternatives for producing sustainable materials at a lower cost. In this research paper, the performance of ground mussel waste for non-structural concrete formulation has been investigated. Two alternatives were explored in this research. The first aimed at incorporating treated Mussel Powder (MP) for partial substitution of cement (6, 12, and 24% by weight). The second aimed to investigate the feasibility of using MP as an additive with a proportion of 3, 6, 9 and 12% by weight of cement. Physical-mechanical properties of advanced composites have been studied in both fresh and hardened state through several laboratory tests. The test results indicated that the inclusion of the MP allowed the formulation of concretes with normal density and lower air content. The mechanical behavior was characterized using new formulas adapted to the newly formulated concretes. Based on the obtained results, the treated MP could be used as a cement substitute with a proportion up to 12% or as a mineral additive with a percentage of 3% to produce a non-structural concrete that meets the normative requirements in terms of compressive and tensile strength. The recycling of mussel waste in concrete will contribute to the preservation of the environment by reducing the quantity of shellfish waste. The concept of “green” concrete can be achieved through the use of the formulated concretes in the paving works or as a blinding concrete.

**Key Words:** Mussel shell waste, Eco-friendly concrete, Sustainability, Physical and mechanical properties, Ductility, Marine waste.

## 1. Introduction

The construction industry has grown due to population growth, primarily using concrete material. Concrete production consumes over 26 Gt of aggregates and 2 Gt of fresh water, leading to depletion of natural resources. The concrete industry is also a major source of pollution, with Portland cement producing around 4.1 Gt/year, contributing to ~9% of global anthropogenic CO2 (Zhang, 2019). Researchers are exploring the use of various wastes as substitutes for conventional aggregates or cementations materials in concrete design. Seashell waste, which makes up 33% of the total mass of mussel shells, can be recycled to substitute concrete components. This waste poses significant environmental problems, including hazardous odors, marine pollution, and infectious disease risks. In Sri Lanka, mussel shells are collected and processed using traditional methods, resulting in hazardous odors, marine environmental pollution, and infectious disease risks (Gharbi, 2018). To address this issue, treated mussel powder is used as a cement substitute and filler material for non-structural concrete formulation (Miller, 2018). This composite can be applied in structures where high strength concrete is not required, such as strengthening and infilling beams, rehabilitating deteriorated columns, and paving works. Shell by-products, such as oysters, cockles, scallops, periwinkles, and mussels, have been explored as partial or total substitutes for various concrete components (Ruiz-Herrero, 2014). However, studies have noted a decrease in compressive strength as substitution rates increase, indicating that mussel waste could improve the compactness of concrete. This

study focuses on the effect of treated mussel powder on the physical and mechanical properties of non-structural concrete, providing a comparative study between the two.

Mussel waste aggregates are characterized by smooth surfaces and thin elongated shapes, which weaken the cement aggregate bond (Gharbi, 2018). Consequently, mussel aggregates will have lower strength compared to natural aggregates. Therefore, it would be useful to use mussel waste in powder form to improve the compactness of the concrete. In this regard, we focused our study on the effect of mussel shell powder (MP) additives on the physical and mechanical properties of nonstructural concrete. The novelty in this work consists of the following points. First of all, the effect of the incorporation of the treated MP as a cement substitute or as a filler material additive in concrete has not been previously studied in the literature (Ruiz-Herrero, 2014). Furthermore, this paper thoroughly characterizes the behavior of the formulated mussel composites. Moreover, this work provides a comparative study between the incorporation of the treated MP as a cement substitute and as a mineral additive in concrete.

## 2.Methodology

### 2.1Materials

*2.1.1 Cement and Aggregates*

The common materials used in the formulation of ordinary concrete are cement and aggregates. Fig. (1) illustrates all components used in the concrete formulation. The used cement is a Portland cement. Table 1 shows the physical properties of aggregates. River sand is used with a maximum particle size of 5mm prepared by a combination of two types of sand, 0/2.5mm and 2.5/5mm, with a proportion of 75% and 25%, respect

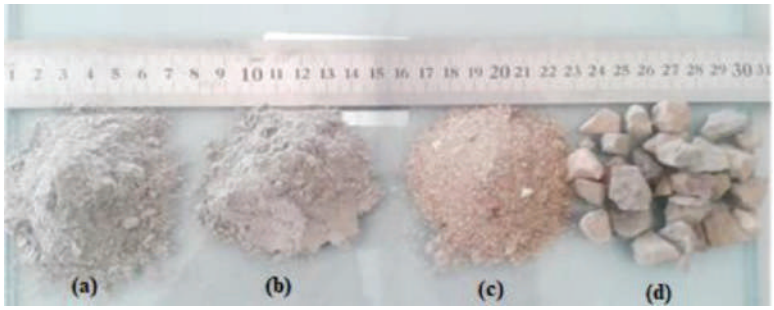


*Fig 1 : Cement (a), mussel powder (b), sand (c), gravel (d).*

Table 1:Physical proprieties of aggregates and mussel powder

| Parameter | Gravel 5/16 | Sand 0/5 | Mussel Powder |
|---|---|---|---|
| Size (mm) | 5/16 | 0/5 | <0.08 |
| Uniformity coefficient | 1.2 | 3.35 | -- |
| Curvature coefficient | 1.15 | 0.7 | -- |
| Bulk density | 1.38 | 1.32 | 1.01 |
| Specific gravity | 2.73 | 2.5 | 2.02 |
| Fineness modulus | -- | 2.26 | -- |

### 2.1.2 Mussel Powder

Mussel shells are collected from northern part paasaiyoor city, Jaffna (Fig. 2).

Fig 2: Mussel shell gathering sites in Jaffna

Collected shells were boiled at high temperatures to allow the opening of the valves and the extraction of the meat. The shells are then washed with water mixed with detergents. This treatment removes the organic matter from the shell and reduces the chloride and sulfide content (Martínez-garcía, 2016). The mussel shells are then air-dried and taken to a traditional lime production site in Jaffna. Mussel shell waste is then thermally calcined in the traditional vertical furnace at a temperature of around 800°C for 6 hours. Calcined shells are finely crushed in a mechanical mill and sieved at 0.08 µm sieve (Fig. 3).

Fig 3: Appearance of mussel shells before and after treatment and grinding.

### 3.2. Mix Design

Two types of mixes were prepared. The first one, called “Mussel Concrete” (MC), is formulated by mass substitution of cement by MP at a rate of 6-12 and 24%. The specimens will be noted MC6, MC12, and MC24, respectively (Benjamin, 2012). The second mixture is called “Mussel Filler Concrete” (MFC). It is formulated with MP as a filler material with 3-6-9 and 12% by weight of cement. The adopted W/(C+Filler) ratio was 0.61. Specimens are noted MFC3, MFC6, MFC9, and MFC12, respectively. The reference concrete (Ref), the MC and the MFC composites formulations are shown in Table 2.

Table 2-Concrete mix design of all specimens in Kg/m3

| Specimen | Cement(g) | MP(g) | Water(g) | Gravel 5/16(g) | Sand 0/5(g) | W/C (%) | W/(C+F)(%) |
|---|---|---|---|---|---|---|---|
| Ref | 312 | 0 | 190 | 1080.3 | 809.45 | 0.61 | ** |
| MC6 | 293.28 | 18.72 | | | | | |
| MC12 | 274.56 | 37.44 | | | | | |
| MC24 | 237.12 | 74.88 | | | | | |
| MFC3 | 312 | 9.36 | 195.95 | 1080.3 | 809.45 | ** | 0.61 |
| MFC6 | | 18.72 | 201.66 | | | | |
| MFC9 | | 28.08 | 207.37 | | | | |
| MFC12 | | 37.44 | 213.07 | | | | |

### 3.3Preparation and Modeling

The preparation of the mixtures was carried out in the ENSA laboratory. Firstly, the aggregates, cement, and MP were mixed. The water was then gradually added while mixing. The mixing operation is continued up to homogenization. The sampling is carried out according to EN 12350-1 standard (Lertwattanaruk, 2012). The filling of cylinder molds was carried out in three layers with manual tamping using a tamping rod. Each layer of concrete was tamped 25 times to eliminate air bubbles. Demolding is carried out after 24 hours. The specimens were kept in a water container until the day of the test, as required by the standard (Fig. 4).

Fig 4: Molding, demolding, and curing of specimens.

### 3.4. Test Program

Table 3 shows the list of performed tests and standards used in this study. Cylindrical specimens of 150mm is used to perform all mechanical tests (Ballester, 2007). The adopted loading speed was 0.4 MPa/s for the compression test and 0.04 MPa/s for the splitting tensile test. Shows an example of the mechanical tests performed in this study.

Table 3: List of tests and standards used in this paper

| Tests | Standard/Method | Age of Specimen |
|---|---|---|
| Fresh density | EN 12350-6 | ** |
| Dry density | EN 12390-7 | 7,14,28 days |
| Compression test | EN 12390-3 | 7;14;28 days |
| Splitting tensile strength | EN 12390-6 | 28 days |

## 2. RESULTS AND DISCUSSION

### Fresh and Hardened Density

Fig 5 Shows the fresh and hardened densities of the different mixes formulated based on MP. For MC mixtures, there is a decrease in fresh density as the substitution rate increases. A decrease of about 2% is noted for MC24. The lower density of the MP compared with cement explains this result (Table 1). An opposite trend is observed for MFC mixes (Miller, 2018). An increase in density is noted with the increasing rate of additions. This result is evident because the MP serves as filler within the concrete, increasing the density of the mix. As the densities are higher than 2000 Kg/m$^3$ , the formulated mixes are classified as ordinary concretes.

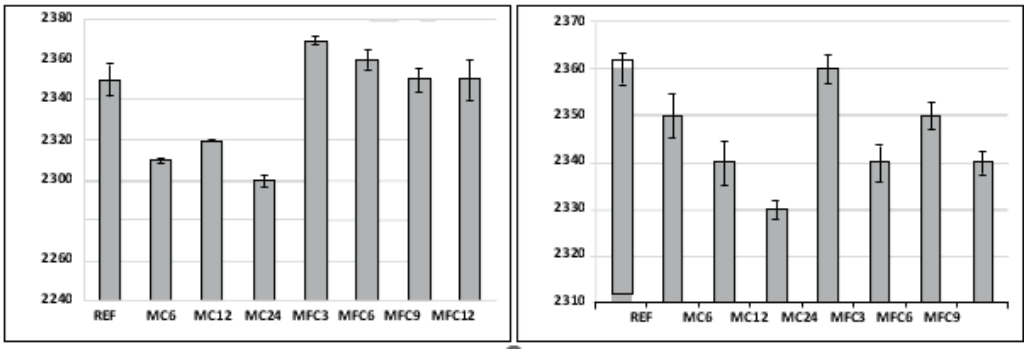


Fig 5: Fresh and hardened density of MC and MFC composites

### 4.3. Compressive Strength

The compressive strength has been determined, according to EN 12390-3 standard (Chang, 2006). Samples are removed from the storage tank on the day of the test. The compressive strength averages at 7, 14, and 28 days are shown in Fig. (6). each value is the average of three tests. As expected, there is an increase in compressive strength with the sample age (Zhang, 2009). The average strength of the reference concrete achieved the target strength in the formulation process (≈20 MPA).

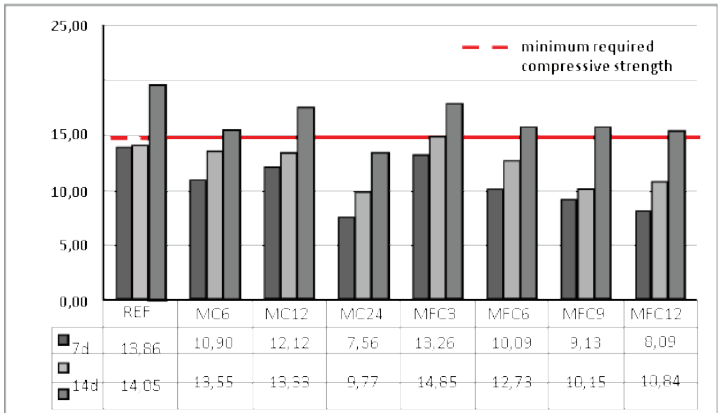


Fig 6: Compressive strength of concretes at 7, 14 and 28 days

A decrease in compressive strength is noted for the MC and MFC mixes compared to the reference concrete. Nevertheless, the majority of mixes have achieved the minimum required strength for non-structural concrete (about 15MPa) except for the MC24 mix.

### 4.6. Splitting Tensile Strength

The tensile strength is the average tensile strength of at least two tests. Table 4 summarizes the obtained results with standard deviation for MC and MFC specimens. The two types of mixes show different mechanical behavior in terms of tensile strength. For MC mixes, a decrease in tensile strength is observed as the substitution rate of cement increases. The tensile strength of MC6 and MC12 remained relatively stable, with a reduction not exceeding 13%, whereas a significant drop of around 33% was noted for MC24 (Varhan, 2017). This result is explained by the fact that MP is not able to bind as well as Portland cement. However, the tensile strength of MFC mixes is nearly similar to the reference concrete. There is even enhancement of the tensile strength for the MFC6 mix.

Table 4. Splitting tensile strength values of all specimens in MPa.

| Sample | REF | MC6 | MC12 | MC24 | MFC3 | MFC6 | MFC9 | MFC12 |
|---|---|---|---|---|---|---|---|---|
| 1 | 2,17 | 1,86 | 1,85 | 1,46 | 2,15 | 2,25 | 2,25 | 2,24 |
| 2 | 2,27 | 2 | 2,04 | 1,53 | 2,28 | 2,26 | 2,12 | 2,17 |
| 3 | ** | ** | ** | ** | ** | 2,30 | 2,18 | ** |
| average | 2,22 | 1,93 | 1,95 | 1,50 | 2,22 | 2,27 | 2,18 | 2,21 |
| Change (%) | 0 | -13 | -12 | -33 | 0 | 2 | -2 | -1 |
| standard deviation | 0,071 | 0,099 | 0,134 | 0,049 | 0,092 | 0,028 | 0,065 | 0,049 |

## Conclusion

In this article, the feasibility of using treated MP for the non-structural concrete formulation was discussed. The MP was used as a cement substitute in the proportion of 6, 12, and 24% and as an additive in the percentage of 3, 6, 9, and 12% by weight of cement. A sequence of tests was carried out to characterize the new composites in both fresh and hardened states. From this experimental study, the following conclusions can be made: The density of MC mixes decreases with the increasing cement substitution rate and is within the range of ordinary concretes. The compressive strength of the MC and MFC formulations meets the minimum required strength for non-structural concrete. The best performances have been achieved at a 12% replacement rate and 3% as a mineral additive. The addition of MP as a mineral additive improves the tensile strength of concrete up to 6%. As a general conclusion, the recycling of mussel waste in concrete will contribute to the preservation of the environment by reducing the quantity of shellfish waste. The concept of “green” concrete can be achieved through the use of the formulated concretes in the paving works or as a blinding concrete. This composite could be used as an infill material for confined beams and columns.

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# A COMPREHENSIVE STUDY ON GREEN BUILDING TECHNOLOGIES IN COMMERCIAL BUILDINGS IN SRI LANKA

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This research study explores the topic of "Green Building Technologies in Commercial Buildings in Sri Lanka," focusing on the significant influence of sustainable building methods on the local environment. Sri Lanka stands out as a major player in the global movement towards eco-friendly building solutions, adopting green technologies to address both economic and environmental issues. The Green buiding construction is becoming increasingly important in the modern world. Because it uses sustainable materials, maximises energy efficiency, and produces less waste, it makes a major contribution to lowering the environmental impact and encouraging healthier living and working environments. The green building construction methods not only reduce carbon emissions but also improve indoor air quality. We begin by bringing attention to the growing significance of sustainable construction methods around the world, highlighting their modern applicability in battling environmental degradation and climate change. In addition, green buildings frequently have greater durability and require less maintenance, which lowers long-term operating expenses. Adopting green building practises stimulates economic growth in the renewable energy industry, encourages innovation, and has a knock-on effect by encouraging a change in lifestyle towards eco-consciousness. The fact that developing nations like Sri Lanka are also adopting green building technologies is a noteworthy development.

As we focus our lens on the Sri Lankan context, we unravel a tapestry of benefits and challenges. From the promise of reduced energy consumption, lower operating costs, and improved indoor air quality to the challenges of higher upfront costs and a lack of awareness, we recognize the need for a comprehensive understanding of the nuances involved in implementing green building technologies. A comprehensive qualitative approach is employed for this research study. The data collection of this research study was done by case studies. The survey conducted between thirty respondents and only twenty respondents were responded to this survey. The findings of this research study were validated by subject matter experts. The research scope was limited to commercial buildings of Sri Lankan construction industry.

## 1. Introduction

The global emphasis on sustainable construction practices is more critical than ever, reflecting a heightened awareness of environmental concerns and a collective commitment to combat climate change. The adoption of green building technologies is increasingly becoming a global norm, extending its influence beyond developed nations to include a growing focus in modern commercial construction worldwide. Beyond the immediate advantages of reduced energy consumption and lower operating costs, we uncover how sustainable practices contribute to

enhancing the brand image of commercial entities, aligning them with contemporary values and fostering a reputation for environmental responsibility. Incorporating the latest statistics on the prevalence of sustainable practices in commercial construction, we provide insights into the evolving regulatory framework that promotes and guides the integration of green technologies. This section offers a nuanced understanding of the specific challenges and opportunities within Sri Lanka's commercial construction sector, contextualizing the global discourse on sustainable building practices within the country's unique context.

### 1.1. *Importance in Modern Construction*

Green building technologies are becoming increasingly relevant in the contemporary commercial construction landscape. As the world becomes more aware of the impact of human activities on the environment, there is a growing demand for sustainable and eco-friendly building practices.

**Table 01**. Overview of Green Building Technologies: Benefits, Challenges, and Cost-Benefit Analysis

| Benefits | Challenges | Cost-Benefit Analysis |
|---|---|---|
| Improved energy efficiency and reduced carbon footprint | Higher upfront costs | Green building tech, while pricier at the start, delivers lasting savings through reduced energy and water consumption. |
| Enhanced indoor air quality and occupant comfort | Limited availability of green building materials and technologies | Enhanced health and productivity result from sustainable practices like improved air quality and design. |
| Reduced water usage and waste generation | Lack of awareness and education among stakeholders | Stakeholders can assess financial gains through a detailed analysis, encouraging sustainable construction. |

Sri Lanka has made significant progress in promoting green building practices, with the government introducing policies and incentives to encourage sustainable construction. However, there is still a need for greater awareness and education among stakeholders, as well as increased availability of green building materials and technologies. According to recent data, the adoption of green practices in commercial construction in Sri Lanka is on the rise. In 2019, the Colombo Municipal Council introduced a green building code that mandates the use of sustainable materials and practices in new commercial constructions.

**Table 02**. Economic Challenges and Solutions in Implementing Green Building Technologies in Sri Lanka

| Economic Challenges | Potential Solutions | Enhancing Awareness and Community Engagement |
|---|---|---|
| High initial costs of implementing green building technologies and lack of financial incentives are major economic challenges faced in Sri Lanka. | Public-private partnerships and government subsidies can be potential solutions to overcome economic challenges in implementing green building technologies in Sri Lanka. | Community outreach programs and educational campaigns can be effective strategies to enhance awareness and community engagement in green construction in Sri Lanka. |

## 2. Methodology

A comprehensive qualitative approach was employed for this research study. A case study was done for the data collection of the research study. The research scope was limited commercial buildings of Sri Lanka. The case study details were given below. The selected buiing have the key features include the integration of solar panels, a green roof, and natural ventilation systems. These technologies collectively contribute to a substantial reduction in energy consumption and the building's carbon footprint..

Fig. 1: Hatton National Bank PLC - Jaffna Metro Branch Bank Building

Fig. 2: Hatton National Bank PLC - Metro Branch during the inauguration

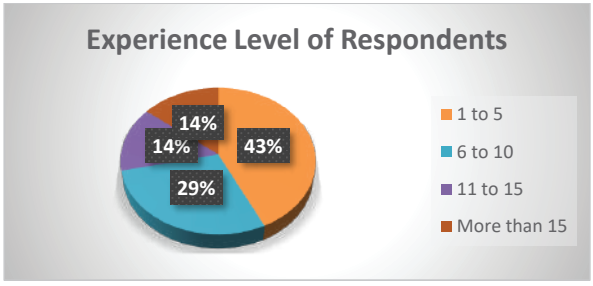


Fig 3: Experience Level of Respondents

### *2.1 Redefining Banking Spaces: Hatton National Bank's Jaffna Metro Branch*

**Table 03;** Project Timeline

| **Client** | **Hatton National Bank** |
|---|---|
| Contractor | Sanken Lanka (pvt). Ltd. |
| Total area | 36,200 sq. ft |
| Project duration | 20 months |
| Commencement | September 2011 |
| Completion | May 2013 |

### *2.2 Embracing Sustainable Innovations: Advantages of Green Building Technologies in Hatton National Bank PLC - Jaffna Metro Branch Bank*

The major objective of this research study focused on, a curated journey through the myriad benefits of embracing green building technologies in Sri Lanka. Here, each choice not only nurtures a healthier environment but also stands as a sound economic investment. Imagine entering a workspace bathed in the soft glow of natural light, crafted to elevate spirits, enhance productivity, and significantly reduce reliance on artificial lighting. Experience the cool comfort of a centralized air conditioning system, intelligently designed for optimal energy use, maximizing the efficiency of electricity consumption. Picture a building that values every raindrop, equipped with rainwater harvesting systems for a sustainable water supply, diminishing dependence on external sources. Cast your vision upward to a rooftop adorned with solar panels silently harnessing the sun's energy, offering a tangible step toward a greener, more sustainable future. Enter a space where waste isn't a burden but an opportunity, with a sewage treatment plant transforming waste into a valuable resource.

### *2.3 Advancing Sustainability: Innovative Technologies Shaping Green Buildings in Hatton National Bank PLC - Jaffna Metro Branch Bank*

Explore the frontier of sustainability with "Innovative Technologies in Green Building: Enhancing Sustainability with Smart Solutions." Witness the future of washroom illumination with advanced light sensors that provide human-centric lighting, automatically adjusting to natural light for optimal brightness and reduced energy consumption. The integration of Closed-Circuit Television (CCTV) systems goes beyond security, contributing to resource efficiency by minimizing the need for additional lighting and physical security measures. Precision cooling takes center stage with timing sensors for the centralized air conditioning system, optimizing energy consumption based on occupancy patterns. Embracing natural ventilation and lighting, louvers systems integrated into windows promote passive cooling by regulating airflow and harnessing natural light, creating a comfortable and eco-friendly indoor environment.

### *2.4 Challenges and Difficulties Faced during the Construction of Hatton National Bank PLC - Jaffna Metro Branch*

- Challenges

Challenges at Hatton National Bank PLC - Jaffna Metro Branch include the necessity to use treated water for the Centralized AC system. The local water in Jaffna contains calcium, requiring

extensive cleaning processes, incurring significant costs. To address this, the implementation of a Reverse Osmosis (RO) plant becomes essential, accompanied by the need for chemicals to purify the water effectively. Overcoming these challenges involves not only financial considerations but also strategic planning for sustainable and efficient water treatment solutions.

- Difficulties

Hatton National Bank PLC - Jaffna Metro Branch faces multifaceted challenges demanding strategic solutions. The rainwater harvesting system encounters bird-related concerns near the solar panels, necessitating rectification to prevent potential contamination of harvested rainwater. Simultaneously, water leakage in the elevator during heavy rains poses electrical risks, requiring a comprehensive approach that might involve reconstruction. This challenge underscores the importance of proactive measures for infrastructure reliability and safety. Furthermore, issues with the remote-controlled mechanical louvers, exacerbated by the unavailability of specialized local contractors, highlight the need for innovative solutions, potentially involving international expertise.

## 3. Results and Discussion

### 3.1. Cost-Benefit Analysis of Green Building Technologies

**Table 04;** Cost-Benefit Analysis

| **Costs and benefit categories** | **Initial cost (LKR)** | **Annual savings (LKR)** | **Payback period (LKR)** | **Net present value (LKR)** |
|---|---|---|---|---|
| Installation of solar panels | 15,000,000 | 3,000,000 | 5 | 12,000,000 |
| Rainwater harvesting systems | 5,000,000 | 1,000,000 | 5 | 4,000,000 |
| Natural ventilation systems | 3,000,000 | 500,000 | 6 | 1,500,000 |
| Energy efficient lighting | 2,000,000 | 300,000 | 7 | 900,000 |
| Total | 25,000,000 | 4,800,000 | - | 18,400,000 |

Green building technologies offer numerous benefits, but they often come at a higher cost compared to conventional approaches. In order to assess the true value of green building technologies, a cost-benefit analysis must be conducted. This case study demonstrates the cost-benefit analysis of green building technologies is the bank building in Jaffna. The building was designed with various green technologies, including solar panels, rainwater harvesting systems, and energy-efficient lighting.

### *2.2. Energy Consumption Trends*

Statistical analysis of the energy consumption patterns in the Hatton National Bank (HNB) Jaffna Metro Branch revealed a notable reduction in energy usage compared to conventional structures. Over a span of two years, the building showcased a consistent decline in electricity consumption, attributed to the efficient integration of solar panels and energy-efficient systems. This data is visually represented in Table 06.

**Table 05;** Energy Consumption Trends

| **Year** | **Monthly Average Energy Consumption (kWh)** | **Annual Total Energy Consumption (kWh)** |
|---|---|---|
| 2020 | 9,500 | 114,000 |
| 2021 | 8,200 | 98,400 |
| 2022 | 7,800 | 93,600 |

This table provides a snapshot of the monthly and annual energy consumption for the years 2020, 2021, and 2022. The decreasing trend in monthly averages indicates a positive impact of green building technologies on energy efficiency.

### *3.3. Carbon Footprint Reduction*

The implementation of green building technologies resulted in a significant reduction in the carbon footprint of the HNB Jaffna Metro Branch. Through the use of renewable energy sources and energy-efficient practices, the building demonstrated a commendable decline in greenhouse gas emissions. Table 07 vividly illustrates this reduction over the monitoring period.

**Table 06;** Carbon Footprint Reduction

| Year | Total Carbon Emissions (tons) | Percentage Reduction Compared to Baseline |
|---|---|---|
| 2020 | 180 | - |
| 2021 | 160 | 11.1% |
| 2022 | 145 | 19.4% |

### *3.4. Occupant Comfort and Productivity*

Survey data from employees within the HNB Jaffna Metro Branch indicated a noteworthy improvement in occupant comfort and productivity. The introduction of natural ventilation systems, coupled with an open floor plan, contributed to enhanced indoor air quality and a more pleasant working environment. The statistical analysis of survey responses is summarized in Table 08.

**Table 07;** Occupant Comfort and Productivity Survey Results

| **Survey category** | **Excellent (%)** | **Good (%)** | **Satisfactory (%)** | **Poor (%)** |
|---|---|---|---|---|
| Indoor air quality | 70 | 20 | 8 | 2 |
| Natural lighting | 75 | 15 | 8 | 2 |

| | | | | |
|---|---|---|---|---|
| Temperature control | 68 | 22 | 7 | 3 |
| Acoustic comfort | 72 | 18 | 7 | 3 |
| Overall workspace | 78 | 15 | 5 | 2 |

These survey results reflect the occupants' perceptions of various comfort factors in the Hatton National Bank's Jaffna Metro Branch Green Building.

## 4. Conclusion

Green building technologies are becoming increasingly important in modern construction, and the bank building case study is a prime example of their benefits. By incorporating sustainable features such as solar panels and rainwater harvesting systems, the bank was able to significantly reduce its environmental impact and save money on energy and water costs. It is important for architects and builders to consider the long-term benefits of green building technologies when planning future projects. While there may be some initial costs involved, the long-term savings and environmental benefits make it a worthwhile investment. We encourage all of our audience members to consider incorporating green building technologies into their future projects. By doing so, we can work towards a more sustainable and environmentally-friendly future for commercial buildings in Sri Lanka and beyond.

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# AN INVESTIGATION OF THE FACTORS THAT AFFECT PROJECT VALUE IN TERMS OF SUSTAINABILITY AND VALUE ENGINEERING

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## Abstract

The aim of this research study is to identifying key aspects of Value Engineering and Sustainability in terms of project value. One of the key sectors controlling the worldwide economy's growth is the building industry. It has challenges nonetheless, and in recent years, the industry has dealt with a number of unusual problems that have had an influence on construction companies, project managers, and the industry as a whole. From energy use to emissions, the building industry has a big impact on the environment. Greenfield development destroys natural ecosystems, but it also uses a lot of energy while it's being built. Fossil fuels continue to be heavily used by heavy construction machinery. The building industry is also responsible for the embodied energy in the building materials and the ongoing energy needs of the structure as it is used. Value engineering is a crucial construction strategy that helps to reduce costs and ensure on-time project completion. Finding places where costs might be cut without affecting the quality of the project as a whole involves leveraging real-world data and technology. It is also employed to evaluate the choice of materials, labour costs, technological advancements, and other construction-related start-up factors. This research study goes into detail about the sustainability idea and value engineering methodologies utilized in the building industry. This paper's main goal was to highlight important aspects of sustainability and value engineering in terms of project value. Semi-structured interviews were used to collect the data for expert interview. Finally, this research will help decision-makers, contractors choose environmentally friendly and sustainability products for future projects, along with sustainability and value engineering approaches.

**Key words:** Sustainability; Value engineering; Construction industry.

## Extended Abstract

### 1. Introduction

The majority of the world's natural resources are used by the construction industry. The building sector now needs to reduce its environmental impact due to climate change, and the government is stepping in to ensure sustainability. Utilizing recyclable and renewable resources in constructing to reduce waste and energy usage is known as sustainable construction. Reducing the negative effects of construction on the environment is the main objective of sustainable construction. Given that the construction sector has a significant environmental impact, sustainable construction is essential. The construction industry has the potential to damage natural areas in addition to using a lot of energy. 36% of the world's energy usage and 40% of its CO2 emissions are attributed to the construction industry. A more efficient use of electricity is needed to prevent wasteful fuel combustion in the industry's heavy gear and equipment. Carbon emissions are also caused by the manufacturing and delivery of

building supplies. Concrete production generates tones of CO2 emissions per year, and it has been discovered that mining for mineral materials pollutes water.

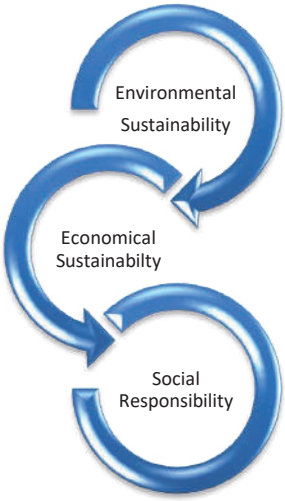


Figure 1; The Core Concepts of Sustainability

Construction firms that desire to adopt a sustainable approach face a number of challenges. Many people are worried about the market's lack of demand, but they are also worried about the high startup costs. For a building to be sustainable, its owner, designers, and builders must all be aware of its constraints and effects. To achieve sustainable building, it is necessary to overcome the disagreement among interested parties, which is caused by a resistance to accept sustainable limitations. The absence of reliable and consistent information about sustainable products and solutions is a key barrier to acceptance of sustainable practices. The inability to communicate knowledge using precise paperwork, including specifications, drawings, and contracts, poses a barrier in addition to the information itself. The technical challenges, such as the availability of information on sustainable materials, easily available teaching, and technical expertise, are another significant obstacle in the application of sustainable construction practices. Because they directly affect how sustainable construction principles are used, these are designated as technical difficulties. Regulations that make it difficult to apply sustainable building practices have serious negative effects.

Value engineering is a crucial construction concept that helps in cost reduction and guarantees on-time project completion. Finding areas where costs might be cut without affecting the quality of the project as a whole requires using technology and data from the actual world. Additionally, it is used to evaluate the choice of materials, labour costs, available technology and equipment, and other construction-related start-up factors. The main challenge faced by Sri Lankan construction companies was a lack of labour and specific raw materials, but over time the industry was able to innovate and overcome these obstacles. However, due to the current economic situation, the industry is now facing a number of issues that can only be resolved by state-level actions. Material expenses are increasing. Delays in payment, Government initiatives that have been put on hold emissions of carbon, Importation difficulties Interest rates have been raised. These are the few problems in Sri Lankan construction firms.

This research study was utilized to highlight critical characteristics of Value Engineering and Sustainability in terms of project value. This objectives of the research study is to investigating the key features of Value Engineering and Sustainability in the construction sector identify challenges to implementing Value Engineering and Sustainability in the construction industry, and provide proposals to overcome the building industry's Value Engineering and Sustainability barriers.

## 2. Methodology

A comprehensive qualitative approach was employed for this research study. Exploring complicated social and behavioural phenomena, comprehending human experiences, and formulating research hypotheses are all common uses for qualitative research. The questionnaire contained the open-ended questions. The questionnaire survey conducted between well experienced industry practitioners. Students, regular people, and businesspeople from Sri Lanka were chosen for this study.

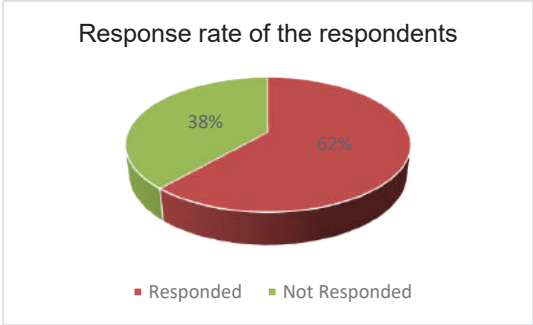


Fig 2; Response rate of respondents

A questionnaire survey was approached in quantitative analysis, while a qualitative analysis involved an expert interview. Semi-structured interviews were used to collect the data for expert interview. Expert interviews were made with construction related professionals. Data for expert interview was conducted among three (05) experts with the aid of judgmental sampling. During the interviews, impact of value engineering was a topic that was covered with each expert. Experts were named as E1, E2, E3, E4, and E5 in this research study. Semi-structured interviews are used as the data collecting strategy to achieve these goals. The research findings were verified by the subject matter expert.

## 3. Results and Discussion

### Objective 1 - Investigating the key features of Value Engineering and Sustainability in the construction sector

Value engineering is a powerful approach for reducing costs and improving quality, particularly when it comes to construction project costs and quality. It has also been shown to have positive effects on the environment and the global trend of green building. Development that is sustainable is that which satisfies current needs without compromising the need of future generations to satisfy their own. The sustainability approach addresses the entire lifecycle of

materials, including water, energy, and materials, from their initial state as raw materials to their eventual salvage cycle.

The semi structured interviews conducted between five industry experts. This below table shows the factors which list out findings of the interview. The first most important principle of value engineering in the construction industry, according to expert 1, is "Assessing the life cycle costs of every possible alternative". A better approach to comparing installation costs is to use life cycle costing evaluation to compare the costs of various alternatives. The construction costs, operation and maintenance costs, repair and replacement costs, renewal costing, demolition cost, and residual value are all included in life cycle costing. Furthermore, expert 1 determined that the primary concept of sustainability in the construction industry is "Use of Recyclable/Reusable Materials".

The expert 2 identified “Come up with distinctive, budget-friendly and creative ideas” is the key concept of value Engineering in construction industry. In addition, the expert 2 further illustrated that “Reduce energy consumption by utilizing low energy sources and renewable sources like solar panel” is the second most key concept of sustainability in construction industry.

**Table 1**; Key features of Value Engineering and Sustainability in Construction Industry

| | Key Features of VE in Construction | Key features of sustainability |
|---|---|---|
| E1 | Assessing the life cycle costs of every possible alternatives | Usage of Recyclable/ Reusable materials |
| E2 | Come up with distinctive, budget-friendly and creative ideas | Reduce energy consumption by utilizing low energy sources and renewable sources like solar panel |
| E3 | Focusing on enhancing the project's value through quality improvements, performance improvements and cost reduction | Make improvement in internal and external environment of inhabitants, Preserve the environmental balance of biodiversity. |
| E4 | Determine which value alternative is the best fit by analysing the cost-benefit analysis | Reduce the water consumption and use technologies like grey water recycling |
| E5 | Recognising possible risks connected to the project and finding ways to reduce them | Protect the natural environment, Improve the well being of the occupants |

**Objective-2 - Identify challenges to implementing Value Engineering and Sustainability in the construction industry**

The semi structured interview conducted between five industry experts. Each experts identify the key challenges to implementing Value Engineering in construction and also it list out key challenges to implement sustainability in construction. The Expert 1 identified that “Less

contractor involvement during the design phase" is the key challenge of implementing value engineering in construction. In addition, "Client's lack of awareness about sustainability" identified as the key challenges to implementing sustainability in construction. When the client or stakeholders have lack of knowledge regarding sustainability, that will reduce the implementation of sustainability in construction industry. In other hand, growing cost of sustainable materials and sustainable technologies are the major challenges in sustainability in construction industry.

**Table 2**; The Challenges to implementing Value Engineering and Sustainability in Construction Industry

| | Challenges of implementation of VE in Construction | Challenges of implementing of sustainability in construction |
|---|---|---|
| E1 | Less contractor involvement during the design phase will restrict the proposals that contractors may offer. | Client's lack of awareness about sustainability, and if this is the case, he doesn't know how to utilize of it. |
| E2 | Using the VE during the construction phase could enhance the completion times | Higher cost of sustainable materials and that will reduce the interest of the client to utilize sustainable materials to the construction |
| E3 | Cost enhancement due to time extension, Lack of understanding among stakeholders about value engineering | Growing costs for sustainable technologies will make clients less inclined to use them in construction. |
| E4 | Additional costing due to appointment of Value Engineering consultants | Governments negligence in promoting sustainability practices in construction industry |
| E5 | The innovative ideas in construction are not well-received or adapted by stakeholders. | Lack of awareness of stakeholders regarding sustainability |

**Objective-3 - Provide methods to overcome the building industry's Value Engineering and Sustainability barriers.**

The semi-structured questionnaire survey was answered by five professionals in the industry. The main recommendation to strengthen Value Engineering (VE) in the construction industry, according to expert 1, is that "Government can make workshops to enhance Value Engineering ideology in construction." The awareness of clients and stakeholders in the construction industry will increase if the government investigates holding additional workshops and training programmes on Value Engineering and sustainability in construction. Furthermore, the key suggestion to enhance sustainability in the construction industry is provided by expert 2's illusory statement, "Government can make tax reductions to the construction companies who employ sustainability in construction." The third expert revealed that the most important way to enhance sustainability in the construction industry is "Improve the research and

development regarding the sustainable technologies in construction". Finding affordable sustainable building materials will be made possible by the advancement of sustainable technology research and development.

**Table 3**; Proposals to overcome the challenges of Value Engineering and Sustainability in construction industry

| | Suggestions to improve VE in Construction | Suggestions to improve of sustainability in construction |
|---|---|---|
| E1 | Government can make workshops to enhance Value Engineering ideology in construction | Government can make workshops to enhance Sustainability awareness between stakeholders in construction |
| E2 | Improve the contractors' involvement in design stage in construction | Government can make tax reductions to the construction companies who employ sustainability in construction |
| E3 | Provide training to the employees regarding the application of Value Engineering in construction industry | Improve the research and development regarding the sustainable technologies in construction |
| E4 | Apply Value Engineering suggestions at the early stage of the construction projects and then there is no point to variations/ time extensions | Government can implement environment regulations and that will allow construction parties to obey stictly |
| E5 | Assess the value alternatives' life cycle analysis and gain the client's approval by outlining its benefits. | Encourage construction companies to use materials that meet the requirements of green building certificates. |

## 4. Conclusions

This case study found that Sri Lanka's building industry is now dealing with a number of issues. Our environment, society, and economy are all significantly impacted by construction activities. Contractors, who are crucial players in the construction sector, and all other stakeholders have a big obligation to get involved in this. A contracting organization's current value engineering and sustainable building practices face significant hurdles related to institutional intervention, people commitment, economic considerations, and education and experience. By increasing awareness of the need to implement or improve sustainable and value engineering practices, stakeholders in the construction industry have a substantial obligation to contribute and transform this into a competitive advantage in the future.

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Session 06

**Languages**

# INTENTION TO IMPLEMENT GREEN HRM PRACTICES IN HIGHER EDUCATION INSTITUTE

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## Abstract

In today's business, the concept of Green Human Resource Management (GHRM) become an emerging topic. It has been observed that planet earth has been harmed in many ways due to the modern competitive business environment. Therefore, members of the organization should consider reducing the negative impact of their business on the society and environment. The study aimed to explore the concept of GHRM policies and practices for environmental sustainability by applying McKinsey 7s model. This study applied a positivism research philosophy as the study was quantitative. Data were analysed through descriptive as well as inferential statistics based on 280 respondents from Advanced Technological Institute (ATI-Dehiwala). Results indicate that the lack of knowledge of the staff on the green concept, lack of management initiative, and lack of management support are the main reasons for not implementing GHRM. It also found that there is no proper training on environmental awareness and GHRM concepts and practices. Therefore, it is necessary to organize training programs, workshops, and seminars on environmental awareness and GHRM practices which will help to gain knowledge of the green concept. Outcomes of analysis also revealed that organization policies, practices, rules, and regulations are not aligned with the green concept. Researcher suggests that admin/HR functions should associate with the green concept for the long-term sustainability of the institution. It would be better if the institution integrates the mission and vision with the green concept for financial, social, and environmental sustainability

Keywords: GHRM, HR policies and practices, Mckinsey 7s, and Sustainability

## 1. Introduction

Due to the growing environmental concerns in today's world, it has been noted that increasing attention on green human resource management (GHRM). It has been observed that increasing focus of the concept of 'going green for the future' among individuals and organisations. Nowadays, academics, organizations, society, and government have been focused on the green concept. The concept of GHRM is about the implementation of human resource policies and practices by linking them with green activities for sustainable development. At present, there is no particular comprehensive definition of GHRM as many experts have given different

definitions. Opatha (2013) defined GHRM as 'the policies, practices, and systems that make employees of the organization green for the benefit of the individual, the business, society, and the natural environment'. Green human resource management (GHRM), known as 'environmental' human resource management, is considered an essential tool for the successful implication of the organization's sustainable development strategy (Renwick, Redman, & Maguire, 2013). Implementing GHRM successfully in an organization is a challenge as it depends on the employer's and employee's commitment, skills, knowledge, and ability to adapt to the system. It is essential to make individuals aware of the green concept to implement GHRM successfully in an organization. Therefore, this study focused on the implementation of GRHM practices in a higher education institute.

## 2. Research Problem

Our planet earth has been harmed in many ways due to the modern competitive business environment. According to NOAA National Centers for Environmental Information, the planet's average surface temperature has risen about 1.62 degrees Fahrenheit (0.9 degrees Celsius). Members of the organization should take responsibility to reduce the negative impact of their business on the society and environment. Cohen, Taylor, & Camen (2012) mentioned that employers should be held accountable for their business impact on society and the environment, alongside economic considerations of growth and profit of the business. Therefore, it is necessary to consider 'the triple bottom line' approach when running a business. Consider environmental sustainability development can help to overcome those problems. Hence, it is needed to educate people on the green concept and applicability of Green HRM practices in the organization. Implementation of GHRM in organizations can play an integral role in sustainability development. Many researchers highlight that the adoption of GHRM practices indicates the success of the business in terms of cost-effectiveness, well-being, and retention of employees. It has been observed that many organizations are still not implementing the GHRM practices due to a lack of awareness. Even though the green concept has been implemented in many organizations, there are no proper clear principles and strategies for GHRM practices. Goel et al., (2022) noted that earlier academicians, researchers, and policymakers had not completely explored strategic aspects, sustainable practices, GHRM policies, rules, and regulations. A key problem for researchers and policymakers is to make awareness of green practices in the organization. This is an especially important problem because many members of the organization are not taking seriously about environmentally friendly practices. Researcher has observed that unnecessary increase in cost for wastages, for instance, keeps switch on

electronic items when not using, more paper usage, throwing cartridges instead of refilling, using more plastic items, consuming more electricity, more paper-based recruitment, less recycling programs, etc. And also, admin or human resource functions are not interconnected with green practices in many organizations. Further, despite extending studies on green HRM, there is less amount of literature on GRHM considering higher educational instructions in Sri Lanka. Additionally, there is no empirical research has been carried out on GHRM in ATI - Dehiwala. Thus, this study seeks to fill such a contextual vacuum by offering a reference research model that is in line with the theoretical and empirical foundations of green HRM. Therefore, this study focuses to explore and implement GHRM policies and practices for environmental sustainability.

### 2.1. Objectives of the study

Research objectives describe what the researcher intend to achieve from the study. It is the result that a researcher seeks to achieve by conducting research. This study aims to explore the concept of GHRM policies and practices for environmental sustainability.

#### 2.1.1. General objective

General objective of the study is to explore the possibilities of implementing GHRM in ATI - Dehiwala. In order to achieve the general objective, researcher has developed following specific objectives:

#### 2.1.2. Specific objectives

- To find the reasons for not implementing GHRM policies and practices
- To identify any weaknesses of the current implemented policies and practices

## 3. Review of the relevant literature

A literature review is a comprehensive and in-depth evaluation of the available literature on the selected research topic area. This study focuses on GHRM by applying McKinsey's 7s approach. The concept of green human resource management (GHRM) was developed when the green movement was started around the world. It is about implementing sustainable practices and increasing awareness of eco-friendly among the workers of the organization. Admin or HR manager should take responsibility to create awareness about GHRM, the green movement among the employees as it is an emerging topic. It has got different meanings to different people. It was identified that organizational strategies for environmental management and sustainable development will succeed when they are well-aligned with human resource

practices (Ichniowski et al., 1997). GHRM is about aligning HRM policies, philosophies, and practices for environmental sustainability. The main purpose of GHRM is the sustainability of the organization by minimizing negative effects on the environment. The achievement of an organization's effort moving towards going green almost depends on the knowledge, skills, attitude, style, and interest of the staff of the organization. When a person commits to environmental goals, she or he has an appropriate change in attitudes and behavior to pursue the green value of the organization. Moreover, their belief in the inherent benefit of environmental commitment is consolidated and, consequently, they are willing to exert extra effort to obtain the success of the organization's green goals (Pinzone et al., 2019). De Silva (2016) suggests that adopting green HRM practices will contribute to employees' well-being, organisational effectiveness, and society well-being, which positively impact on environmental sustainability. In green HRM various human resource practices, such as recruitment, selection, performance appraisal, compensation, and training, are designed in a manner to create a workforce that understands and promotes green behavior in the organization (Mathapati,2013). Opatha and Arulrajah (2014) explained GRHM as the policies, practices, and systems that make employees of the organization green for the benefit of the individuals, society, the natural environment, and businesses. Green initiatives within human resource management form part of wider programs of corporate social responsibility. They are the ones responsible for planning and executing those eco-friendly policies to create a green atmosphere. Therefore, without facilitating human resources and implementing sustainable policies, going green would be a hard nut to crack (Ahmad, 2015). Numerous studies have been carried out all across the world by many scholars on GHRM. However, it has been observed that there are very few studies available on GHRM applying McKinsey 7s model. This study relates McKinsey's 7s model to implement GHRM practices successfully. The model was developed by McKinsey consultants Tom Peters, Robert Waterman, and Julien Philips with help from Richard Pascale and Anthony G. Athos in the 1980s (Hawari et al., 2022). Suwanda et al., (2022) mentioned that the McKinsey Model 7s approach is a tool for investigating an organization's internal operations as a whole, allowing for the diagnosis of internal organizational issues and the subsequent development of an implementation plan. The authors also stated that this model is applicable in all sectors to measure the internal factors of the organization. The model emphasized the interrelation and interconnection between seven aspects such as strategy, structure, system, style, staff, skill, and shared value in an organization. Considering the above points, the present study is an attempt to provide simplified insights on the implementation of GHRM practices applying the McKinsey Model 7s approach.

## 4. Methods

This study applied a positivism research philosophy where factual knowledge are drawn through the examination of facts and the generalization of findings are based on data and statistics. According to Crowther and Lancaster (2008), positivist studies usually adopt a deductive research approach. Therefore, a deductive research approach and survey strategy were chosen for this study. The cross-sectional time horizon was adopted because the current study fulfilled the research objectives at only one point in time by collecting data from the selected sample units of the population.

### 4.1. Conceptual framework of the study

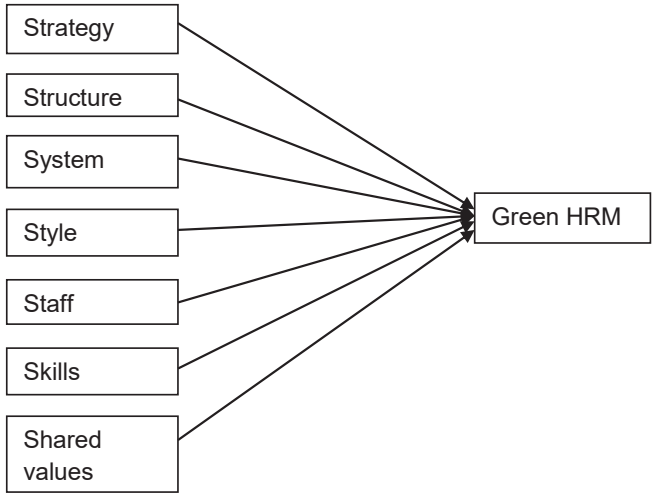


Figure 1: Conceptual Framework

Figure 1 represents the conceptual framework of the study which was developed based on the variables identified in the previous studies. Here, the researcher considers, GHRM as a dependent variable which was measured using five dimensions namely green job analysis, green recruitment and selection, green training, green performance appraisal, and green reward. McKinsey 7s approach aspects such as strategy, structure, system, style, staff, skills, and share values were considered as independent variables.

### 4.2. Hypothesis of the study

With the empirical evidence from the literature and the researcher own reasoning the following hypotheses have been formulated.

H1: There is a significant relationship between organisation strategy and implementation of GHRM

H2: There is a negative relationship between organization structure and implementation of GHRM

H3: Organisation system positively influence on the implementation of GHRM

H4: Leadership style positively influence on the implementation of GHRM

H5: There is a significant relationship between staff and implementation of GHRM

H6: Skills positively influence on the implementation of GHRM

H7: There is a positive relationship between shared values and implementation of GHRM

**4.3 Population and sampling**

In statistics, a population is the entire group of individuals or events for which some information is required to be determined for a study. The target population of the study was students who are pursuing a higher national diploma in management, business finance, and business administration at ATI - Dehiwala. Sampling is the process of selecting a statistically representative sample of individuals from the population of interest to provide an adequate description and inferences of the population. The sample size of the study was 280 which was selected using a proportionate stratified random sampling technique. In a proportionate stratified sampling method, the sample size of each stratum is proportionate to the population size of the stratum, so this sampling technique is suitable for a population with different attributes (Weerakoon et al., 2021).

**4.4 Data collection**

The findings of the study were generalized based on the primary data. Primary data were collected from the respondents who are following a higher national diploma in management, business finance, and business administration. A questionnaire was designed to explore the concept of GHRM applying the McKinsey 7s model. It was divided into three sections where 1st part measured the demographic factors of the respondents, the 2nd part measured the Mckinsey 7s approach and GHRM and 3rd part checked the opinion of respondents on the implementation of GHRM. All the variables were measured using a seven-point Likert scale where 1 represents “lowest value”, 4 represents “neutral”, and 7 represents “highest value”. The dependent variable GHRM was measured using five dimensions and each dimension was measured with a minimum of two indicators. Each independent variable was measured with minimum of two indicators.

## 5. Data analysis

Data were examined and interpreted based on the 280 respondents. Based on the analysis, female respondents (83%) are higher than males which is only 17%. In terms of age, the dominant aged group is between 22-25 years which is 67%, 21% are above 25 years and only 12 % are between 18-21 years old. Considering the years of the following course, 38% are from the 2nd year, 34% are from the 1st year and 28% are from the 3rd year. It also shows that most of the respondents (46%) belong to the management course followed by 29% from business administration and 25% from business finance. Cronbach Alpha 0.749 and 0.893 suggests that the questionnaire used for data collection is highly reliable which were calculated based on the 10 items dependent variable and 17 items for independent variables.

### 5.1 Opinion on GHRM

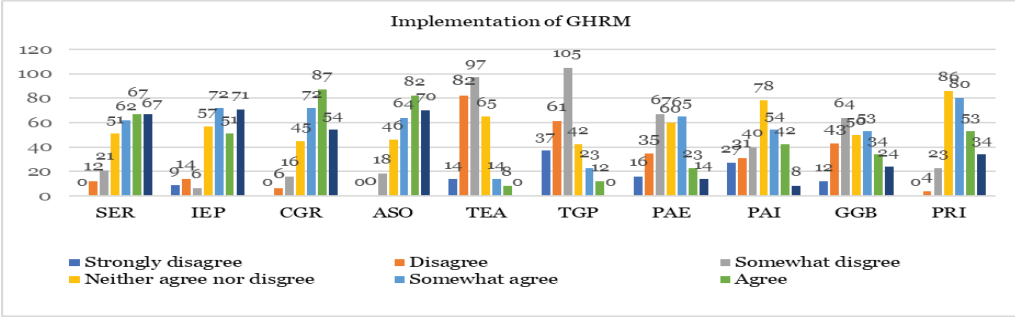


Figure 2: Opinion on GHRM

Figure 2 represents the opinion of respondents on GHRM. It was measured using 10 indicators such as SER ( Assigned social and environmental responsibilities), IEP (Duties and responsibilities are incorporated with environmental protection), CGR (Consider green criteria in the recruitment process), ASO (Advertising and screening are carried out through online), TEA (Provides training on environmental awareness), TGP (Provides training on green HRM concept and practices), PAE (Performance appraisal aligns with environmental responsibility), PAI (Include green performance indicators in performance appraisal), GGB (Gain green benefits), and PRI (Praise and recognize about green involvement activities). The result in figure 2 indicates 196 respondents agreed on the assigned social and environmental responsibilities and only 33 respondents disagreed with the statement. Most of the respondents accept the statements on CGR (Consider green criteria in the recruitment process), ASO (Advertising and screening are carried out online). However, it also reveals that 193 and 203 respondents disagreed on TEA (provides training on environmental awareness), TGP (Provides training on

green HRM concepts and practices) whereas only 22 and 35 agreed on the statements. It also shows that 102 and 104 respondents agreed with the green performance appraisal statements and 119 respondents disagreed with GGB (Gain green benefits to staff) statement.

### 5.2 Overall general knowledge of GHRM

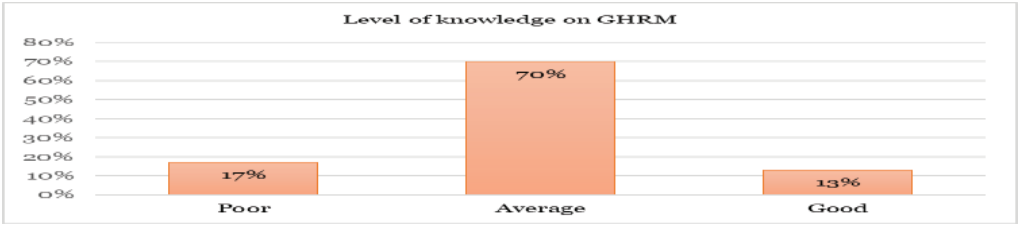


Figure 3: Knowledge of GHRM

The overall general understanding of GHRM is represented in Figure 3. According to the graph, 17% of respondents have poor knowledge of GHRM, while the majority (70%) have average knowledge and only 13% have good knowledge. Based on the result, it can say that most of the respondents don't have clear understanding knowledge on GHRM.

### 5.3 Correlation of variables

Table 1: Correlation

**Correlations**

| | | OSG | OST | OSM | MLS | OSF | SOS | OSV | GHRM |
|---|---|---|---|---|---|---|---|---|---|
| OSG | Pearson Correlation | 1 | .693** | .958** | .952** | .919** | .980** | .981** | .978** |
| | Sig. (2-tailed) | | .000 | .000 | .000 | .000 | .000 | .000 | .000 |
| | N | 280 | 280 | 280 | 280 | 280 | 280 | 280 | 280 |
| OST | Pearson Correlation | .693** | 1 | .678** | .653** | .654** | .696** | .677** | .676** |
| | Sig. (2-tailed) | .000 | | .000 | .000 | .000 | .000 | .000 | .000 |
| | N | 280 | 280 | 280 | 280 | 280 | 280 | 280 | 280 |
| OSM | Pearson Correlation | .958** | .678** | 1 | .920** | .906** | .947** | .931** | .936** |
| | Sig. (2-tailed) | .000 | .000 | | .000 | .000 | .000 | .000 | .000 |
| | N | 280 | 280 | 280 | 280 | 280 | 280 | 280 | 280 |
| MLS | Pearson Correlation | .952** | .653** | .920** | 1 | .875** | .937** | .934** | .929** |
| | Sig. (2-tailed) | .000 | .000 | .000 | | .000 | .000 | .000 | .000 |
| | N | 280 | 280 | 280 | 280 | 280 | 280 | 280 | 280 |
| OSF | Pearson Correlation | .919** | .654** | .906** | .875** | 1 | .939** | .901** | .915** |
| | Sig. (2-tailed) | .000 | .000 | .000 | .000 | | .000 | .000 | .000 |
| | N | 280 | 280 | 280 | 280 | 280 | 280 | 280 | 280 |
| SOS | Pearson Correlation | .980** | .696** | .947** | .937** | .939** | 1 | .963** | .963** |
| | Sig. (2-tailed) | .000 | .000 | .000 | .000 | .000 | | .000 | .000 |
| | N | 280 | 280 | 280 | 280 | 280 | 280 | 280 | 280 |
| OSV | Pearson Correlation | .981** | .677** | .931** | .934** | .901** | .963** | 1 | .977** |
| | Sig. (2-tailed) | .000 | .000 | .000 | .000 | .000 | .000 | | .000 |
| | N | 280 | 280 | 280 | 280 | 280 | 280 | 280 | 280 |
| GHRM | Pearson Correlation | .978** | .676** | .936** | .929** | .915** | .963** | .977** | 1 |
| | Sig. (2-tailed) | .000 | .000 | .000 | .000 | .000 | .000 | .000 | |
| | N | 280 | 280 | 280 | 280 | 280 | 280 | 280 | 280 |

**. Correlation is significant at the 0.01 level (2-tailed).

Correlations estimate the strength of the linear relationship between two variables. The values of Pearson Correlation range from -1 to +1 with negative numbers representing a negative correlation and positive numbers representing a positive correlation between variables. Based on the correlation table 1, all the variables are significant at 0.01. It shows that there is a significant positive relationship between organization strategy (OSG) and implementation of GHRM by indicating a correlation coefficient (r) value of .978 which has a strong positive

relationship. Hence H1 has been accepted. The result reveals a moderate positive relationship between organization structure (OST) and implementation of GHRM. Therefore, H2 has been rejected. It also shows a significant positive relationship between staff (OSF) and implementation of GHRM which supports H5. It also found a positive relationship between shared values and implementation of GHRM where the r value is .977 which shows a strong positive relationship. Consequently, H7 has been proven.

### 5.4 Regression Analysis

Table 2: Model Summary

**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .983[a] | .967 | .966 | .225 |

a. Predictors: (Constant), OSV, OST, OSM, MLS, OSF, SOS, OSG

Table 2 represents the model summary which provides R, R square, and adjusted R square. R value of 0.983 indicates a good level of prediction.

Table 3: Model fit

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 396.218 | 7 | 56.603 | 1121.788 | .000[b] |
| | Residual | 13.724 | 272 | .050 | | |
| | Total | 409.943 | 279 | | | |

a. Dependent Variable: GHRM
b. Predictors: (Constant), OSV, OST, OSM, MLS, OSF, SOS, OSG

Analysis of Variance (ANOVA) provides information about the levels of variability within a regression model. It tests overall regression model is a good fit for the data. Table 3 indicates the independent variables statistically significantly predict the dependent variable which means the regression model is fit where a p-value of .000 is less than a 0.05 alpha value.

Table 4: Coefficient

**Coefficients[a]**

| Model | | Unstandardized Coefficients B | Unstandardized Coefficients Std. Error | Standardized Coefficients Beta | t | Sig. | Collinearity Statistics Tolerance | Collinearity Statistics VIF |
|---|---|---|---|---|---|---|---|---|
| 1 | (Constant) | .162 | .069 | | 2.338 | .020 | | |
| | OSG | .442 | .077 | .451 | 5.738 | .000 | .620 | 1.117 |
| | OST | -.001 | .012 | -.002 | -.104 | .617 | .512 | 1.952 |
| | OSM | .015 | .020 | .005 | .226 | .021 | .468 | 2.134 |
| | MLS | .416 | .026 | .045 | 1.691 | .032 | .773 | 2.439 |
| | OSF | .117 | .030 | .121 | 3.845 | .000 | .625 | 1.985 |
| | SOS | .015 | .052 | .015 | .288 | .034 | .463 | 1.595 |
| | OSV | .480 | .057 | .485 | 8.385 | .000 | .837 | 2.189 |

a. Dependent Variable: GHRM

To determine the significance levels and the effects of independent variables on the dependent variable, a multiple regression analysis was conducted. Based on coefficient table 4, the result indicates that all the independent variable significant p-values are less than 0.05 except organizational structure (OST) where the p-value is higher than 0.05 significant level. Unstandardized coefficients explain how much the dependent variable that is GHRM varies with an independent variable when all other independent variables are held constant. It demonstrates that a 1point increase in the OSM (organization system), MLS (management leadership style), and SOS (skills of staff) leads to an increase in the implementation of GHRM by 0.015, 0.416, and 0.015 which proves H3, H4, and H6. Therefore, system, style, and skills positively influence the implementation of GHRM which accept H3, H4, and H6. It also reveals that GHRM is highly influenced by OSV (organization share value) at 0.480 followed by OSG (organization strategy) at 0.442. However, OST (organization structure) value of 0.617 is greater than the acceptable significant value of 0.05. It means that there is no significant change in the implementation of GHRM due to organization structure. It also reveals that there are no collinearity issues among the variables where the VIF values are less than the recommended value of 2.5 and tolerance values are higher than 0.40.

## 6. Results and Discussion

With the McChesney 7s approach, the study sought to investigate the idea of GHRM (Green Human Resource Management). The study presents insights and challenges faced in the implementation of GHRM. The findings of this study may be utilized to identify the GHRM's most important components for its implementation. Without any doubt, the implementation of GHRM has been covered extensively in recent literature. It also noted that there has been little research on GHRM concerning higher educational institutions in Sri Lanka. Therefore, this study filled the empirical and contextual gaps. The result shows that the majority (83%) of respondents are females whereas only 17 are males. Most of the respondents (67%) are between 22-25 years old. 128 respondents are students who are following management course and the highest number of respondents are from 2nd year. The reliability and validity of the items measuring the McKinsey 7s approach and GHRM were tested. Based on the results, respondents agreed in most of the statements as IGC, AER, CAA, ITG, WGC, CGC, AIG, WEP, BPI, and BOR where mean values are 5.39, 6.22, 6.32, 5.86, 6.31,5.30, 5.30, 6.21, 6.17 and 5.90. However, it found that respondents marked "average" on the indicators ICM, MAS, and KGC and disagreed on the indicators PPG, MGC, and MIG which meant that lack of management initiation (MIG), support (MAS), knowledge of staff (KGC) of implementation of

GHRM as results of this study are in parallel with Goel et al., (2022). Results revealed that organization plans, policies, practices, rules, and regulations are not properly integrated with GHRM. It also indicates that job analysis, recruitment and selection, and performance appraisal are certainly aligned with GHRM. However, it also found that there is no proper training on environmental awareness and GHRM concept and practices as only 22 and 35 agreed on the statements “TEA (provides training on environmental awareness)”, and “TGP (Provides training on green HRM concept and practices)” as similar findings with Mukherjee et al., (2020). Based on the analysis results, it can say that lack of proper knowledge of GHRM as only 13% revealed a good understanding level of the GHRM concept but 70 % marked “average” and 17% has poor knowledge and understanding of the concept of GHRM. All the McKinsey 7s aspects have a significant positive relationship with GHRM which support H1, H5, and H7. However, H2 is not supported as the organization structure has a moderate positive relationship with GHRM. It also found that organization strategy, system, leadership, staff, skills, and share value positively influence GHRM by 44%, 1.5%, 41%, 11%, 1.5%, and 48% except for organization structure which supports H3, H4, and H6. Based on the result of open suggestions, most of the respondents willing to adopt GHRM practices in the institution. Respondents suggest on more training on GHRM practices, engage green activities, green test, develop proper plan for implementation of GHRM, motivate staff to green practices and create greening environment, etc. Many respondents suggest the positive opinion on the implementation of GHRM.

## 7. Conclusion and Recommendations

This study explores concept of green human resource management (GHRM) with McKinsey 7s approach. The conclusion of the study was drawn based on primary data gathered from 280 respondents using a proportionate stratified random sample technique. It was evident from the result that all the McKinsey 7s aspects have a significant positive relationship with the implementation of GHRM except organization structure. Results indicate that some of the reasons for not implementing GHRM are lack of knowledge, lack of management initiative, and lack of management support. Outcomes of analysis also revealed that organization policies, practices, rules, and regulations are not aligned with the green concept. It found that the majority of the respondents don’t have proper knowledge of GHRM as the institution doesn’t conduct proper training on environmental awareness, green concepts, and GHRM policies and practices. Therefore, it is very important to educate on environment awareness, green concepts, and GHRM which will help for the long-term sustainability of the institution. It is also necessary for management initiative and supports to implement GHRM successfully in the institution.

Institution policies, practices, and regulations need to upgrade by aligning with GHRM. However, it found that job analysis, recruitment & selection, and performance appraisal are certainly incorporated with GHRM. It seems that there is no proper implementation of GHRM even though the green concept certainly aligns with HRM functions. Organizational policies, practices, rules, and regulations are not aligned with the green concept and admin/HR functions are not associated with the green concept can be considered as weaknesses of the current system. Researcher suggests that admin/HR functions should associate with the green concept for the long-term sustainability of the institution. Additionally, recognizing and rewarding green performance will encourage students and staff to adopt green practices. It was evident from the result that organization strategy, system, leadership, staff, skills, and share value positively influence the GHRM. It suggests that the mission and vision of the institution should integrate with the green concept for institution and environmental sustainability. Furthermore, management, staff, and students should take green initiatives in the institution in terms of more plantation, less plastics, paper-free, switching off lights if not using, solar panels, using an eco-friendly product, and follow five Rs (refuse, reduce, reuse, repurpose and recycle) system, etc. Therefore, successful implementation of green HRM practices will results in work efficiency, lower cost, promoting innovation, and creativity, employee motivation, well-being and health of the employees, developed positive relations with the community, and building the image of the organization as well as reducing environmental issues.

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# ISSUES AND CHALLENGES FACED BY STUDENTS OF INTERNATIONAL SCHOOLS IN THE COMPETITIVE EDUCATION SYSTEM

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## 1.Abstract

This research conducted to examine the Issues and Problems faced by the students of the international school students. As students are the most valuable resources of the country, it is very important to identify the problems faced by the students.

To gather primary data structured Questionnaire was used. Secondary data were collected through the journals, internet, and website and research articles. Questionnaire consists with

- The first part of the questionnaire included demographic data. (Age, gender, Education, occupation, religion and Residence.)
- The second part of the questionnaire design to measure the issues faced by the students who study in international schools of Trincomalee district by using **Tick the appropriate response scale**. This part of the questionnaire included the question which measure the **attitude** of respondents.
- The third part of the questionnaire design to measure the issues faced by the students who study in international schools of Trincomalee district by using **5point Likert scale**. This part of the questionnaire included the question which measure the **knowledge** and **Education related awareness** of respondents.

The research was carried out by using the one sample t-test, Independent Sample t –test and regression to test hypothesis. Through this measure the degree of issues faced by the students who study in international schools of Trincomalee district vary according to the demographic factors.

A Total of **60** respondent were selected as a sample in the Trincomalee to carry out the research, Convenient sampling used. Data analysis was done through the **SPSS** software. Data of the study presented by using charts and graphs. And hypothesis testing is presented using statistical tables.

**Keywords**: issues, challenges, students, international schools, Trincomalee district

## 2.Extended Abstract

## Introduction

### 2.1 Background of the study

International schools which provide a standard education in Sri Lanka are now undergoing some major issues and problems. Most of the international schools provide the education system in the English language and it's criticized by some as, Students should learn in their own language, and Money plays the major role in the international school's education system, so it raises a question, how can it be a good one. Then, the students who finish their studies in international schools are not in taken by the Government Universities in Sri Lanka. And, because of the increased in the number of international schools, now, the education is being used as a competitive matter.

some reports were recorded as, international schools show different type of inequalities. And, other international schools give heavy competitions in between them and, always tries to pull down the one on the top and climb up to the number one position. For that the international schools use different strategies, but the ones who get affected by these activities are, the children who study in those schools, so they have to be examined carefully.

### 2.2 Statement of the problem

In the competitive education system, it's very important to measure the issues and problems faced by the students who study in the international schools. now in Sri Lanka International Schools are playing a prominent role in the Education System. But now a days in the competitive education system, international schools face many Issues and Challenges. The most frequent allegation leveled against international education is that it hides inequalities and disparities between students under a fiction of equality and competition in between other international schools and with the Government school is another prominent issue faced by the international schools now a days. Because of this situation, Student who study in the international schools are undergoing some problems. And Next issue raised against the international education is university intake has become progressively more competitive throughout the years due to the limited number of placements available. Moreover, many students who pass out from international schools with Edexel or International Baccalaureate or any other equivalent qualification are not able to find a place in local universities, it creates the Question in future of the international education in Sri Lanka and student's future who studied there. Therefore, International schools which provide the international education, has to make some major changes or adapt or change their selves to suit the Education system in Sri Lanka

### 2.3 Significance of the study

Education is the most important thing which has to be neutral and, which is essential to distributed among everyone without any partiality. It nourishes the thought in the mind of the human and make way for the better future. This most important education is facing some problems through the some of the problems going on in the international schools. Many educationists have pointed to the lack of knowledge of English among school leavers. They see it as a fundamental flaw because of their perception of English as the sole window to advanced knowledge. But they ignore other countries big and small which are economically and industrially advanced that provide school education in the mother tongue. Freeing ourselves of such colonial mindset is important—but that does not mean rejection of English as a useful language. We need to elevate the use of the native languages to meet the growing demands of modernity. Switching to English medium education has, predictably, failed to produce results since the emphasis on English disregards difficulties faced in learning in an alien language. This brings us to another badly misunderstood purpose of education, namely producing people who can find employment in the global employment market. This is an unhealthy outcome of the open economic policy followed since 1978, when the notion of a national economy was rejected in the interest of the open economic policy with unrestricted inflow of foreign capital and goods. While investment in school infrastructure, educational reforms and decentralization of the education system are important, integration of education with national needs should be a priority whose achievement demands a healthier approach to education at public level and greater involvement of the public in education policy and process. In Sri Lanka, both government and international private schools are giving education facility. But because of the competitive education system prevailing in those time, the international schools are facing some issues and challenges. This research will help to find out what are the major challenges faced by the international schools and, what are the main issues arises from those challenges and, what are the ways which could be used to overcome those challenges and issues. Because according to a report in future, the number of students who is going to study in international schools will rise in numbers. Therefore, it's very important to handle a problem free international education to our children in future.

### 2.4 Research Questions

The issues and challenges which are faced by the international schools in the competitive education system has to be eliminated, for that we have to list out the issues and problems. It brings us some questions to be found answers, to overcome those issues. Those are the main

questions which answers must be found to overcome the issues faced by the international schools in the Trincomalee district area. Below are the questions.

1. What are the major competitions for the international schools?

2. What are the challenges arising for the international schools for the students in the system?
3.What are the issues faced by international school students in the competitive system?
4. What are the tactics or techniques can be used to overcome the issues?

### 2.5 Research Objectives

Specifically, this study is intended to achieve the following objectives

1. Find out, what are the major issues or challenges faced by the international schools.

2. To identify the major factors behind those issues and challenges.

3. To make suggestions to overcome the issues and challenges.

### 2.6 Research Hypotheses

- H1: The degree of the care people has about the international school student's challenges is low.
- H2: challenges faced by the international school students significantly vary according to their gender
- H3: Protection of the children education is significantly varying according to their residence
- H4: challenges faced by the international school students significantly vary according to their Age
- H5: challenges faced by the international school students significantly vary according to their religion.
- H6: challenges faced by the international school student's generation significantly vary according to their parent's occupation.
- H7: challenges faced by the international school students significantly vary according to their parent's Education level.

### 2.7 Methodology

Research design is the framework that will seek answers to research question. The function of the research design is to ensure that the evidence obtained enable you to effectively address the research problem, logically and as unambiguously as possible. And the set of methods and procedures will be used in collecting and analyzing measures of the variables specified in the research problem.

The main purpose of this chapter to explain the ways and methods used to carry out the research. Here, the independent and dependent variables will be identified separately. It will explain step by step how the research is being conducted including research design, sampling, operationalization, development measurement scale and the questionnaire.

- The first part of the questionnaire included demographic data. (Age, gender, Education, occupation, religion and Residence.)
- The second part of the questionnaire design to find the idea by using **Tick the appropriate response scale**. This part of the questionnaire included the question which measure the **attitude** of respondents.
- The third part of the questionnaire design to measure the idea of people by using **5-point Likert scale**. This part of the questionnaire included the question which measure the **knowledge** of respondents.

As a population, I am focusing on parents of the international school students in Trincomalee district by covering every international school. I will approach 60 parents. And this sample select randomly. And, to analyze data and give the conclusion SPSS software has been used.

This research conduct to take information from young generation so I will take information from parents of the international school students whose age from 6 to 19 years. As they have fresh ideas and they have enough time to do something to the society.

But I should ensure they have enough knowledge about the international schools and they are willing to act in social friendly.

The main purpose of the primary data to identify the hidden insight of the target population. Individuals provide information when interview, administered questionnaire or observed, focus group, in-depth interview are the source of primary data. This research can be categorized as descriptive research. Therefore, it can use survey or observation to collect data.

This research basically distributed questionnaire survey to gather primary data. These data were gathered from 60 respondents via distributing questionnaire. This included different kinds of questions such as unstructured questions and structured questions.

Structured question such as open-ended questions used to take general opinion. And used some structured questions are multiple choice questions, Dichotomous questions and Scaling questions to measure the degree of the social educational concern and take insight for research problem.

### 2.8 Limitation of the study

- Further research should draw upon a larger sample of people of international school parents concern in Trincomalee District.
- Current study collects only quantitative data but in future, qualitative data also important to get more insight about the people's behavior.
- People reluctant to fill questionnaire because it takes much time. So, it will be very difficult to collect accurate data. During this research,
- Only people who were taken under consideration are youngsters, people who are lower age and, older age have not considered here. therefore, the results can't be 100% accurate. It's the most important limitation of this research.

### 2.9 Literature review

#### 2.9.1 Chapter Introduction

Education is the most important thing which differentiates man from the Animals. It makes us significant and Powerful in the world. Development in the education sector, started long ago. Now all over the world, most of the people in the world are educated. If we consider Our Country, Sri Lanka's population has a literacy rate of 92% higher than that expected for a third world country; it has the highest literacy rate in South Asia and overall, one of the highest literacy rates in Asia. Modern education system was brought about with the integration of Sri Lanka in to the British Empire in the 19th century and it falls under the control of both the Central Government and the Provincial Councils. In addition to government schools, the International and Private schools were introduced in Sri Lanka. International Schools charge fees and they have separate curriculum and education is usually in English medium. International Schools became popular among families who wanted their children to study in

English medium, possible with a view to continuing their studies overseas. Some parents have to put their child in a private school when they are not selected to a popular government school.

Likewise, now in Sri Lanka International Schools are playing a prominent role in the Education System. But now a days in the competitive education system, international schools face many Issues and Challenges. The most frequent allegation leveled against international education is that it hides inequalities and disparities between students under a fiction of equality and competition in between other international schools and with the Government school is another prominent issue faced by the international schools now a days. Because of this situation, Student who study in the international schools are undergoing some problems. And Next issue raised against the international education is university intake has become progressively more competitive throughout the years due to the limited number of placements available. Moreover, many students who pass out from international schools with Edexel or International Baccalaureate or any other equivalent qualification are not able to find a place in local universities, it creates the Question in future of the international education in Sri Lanka and student's future who studied there. Therefore, International schools which provide the international education, has to make some major changes or adapt or change their selves to suit the Education system in Sri Lanka.

International schools which provide a standard education in Sri Lanka are now undergoing some major issues and problems. Most of the international schools provide the education system in the English language and it's criticized by some as, Students should learn in their own language, and Money plays the major role in the international school's education system, so it raises a question, how can it be a good one. Then, the students who finish their studies in international schools are not in taken by the Government Universities in Sri Lanka. And, because of the increased in the number of international schools, now, the education is being used as a competitive matter.

some reports were recorded as, international schools show different type of inequalities. And, other international schools give heavy competitions in between them and, always tries to pull down the one on the top and climb up to the number one position. For that the international schools use different strategies, but the ones who get affected by these activities are, the children who study in those schools have to be taken enough care and attention.

Education is the most important thing which has to be neutral and, which is essential to distributed among everyone without any partiality. It nourishes the thought in the mind of the

human and make way for the better future. This most important education is facing some problems through the some of the problems going on in the international schools. Many educationists have pointed to the lack of knowledge of English among school leavers. They see it as a fundamental flaw because of their perception of English as the sole window to advanced knowledge. But they ignore other countries big and small which are economically and industrially advanced that provide school education in the mother tongue. Freeing ourselves of such colonial mindset is important—but that does not mean rejection of English as a useful language. We need to elevate the use of the native languages to meet the growing demands of modernity. Switching to English medium education has, predictably, failed to produce results since the emphasis on English disregards difficulties faced in learning in an alien language. This brings us to another badly misunderstood purpose of education, namely producing people who can find employment in the global employment market. This is an unhealthy outcome of the open economic policy followed since 1978, when the notion of a national economy was rejected in the interest of the open economic policy with unrestricted inflow of foreign capital and goods. While investment in school infrastructure, educational reforms and decentralization of the education system are important, integration of education with national needs should be a priority whose achievement demands a healthier approach to education at public level and greater involvement of the public in education policy and process. In Sri Lanka, both government and international private schools are giving education facility. But because of the competitive education system prevailing in those time, the international schools are facing some issues and challenges. This research will help to find out what are the major challenges faced by the international schools and, what are the main issues arises from those challenges and, what are the ways which could be used to overcome those challenges and issues. Because according to a report in future, the number of students who is going to study in international schools will rise in numbers. Therefore, it's very important to handle a problem free international education to our children in future.

If we are to realistically address the increasing demand for quality education in a debt strapped developing country such as ours, it is essential to allow a parallel system of private education opportunities within a policy environment that makes entry affordable and accurate information better available.

n its Budget for 2022 the Government has reiterated its commitment to provide no interest loans to students pursuing higher education in non-State universities. This is a long overdue recognition of the role played by the private sector in expanding opportunities in higher education. Recognition for private contributions should be extended to school education too but with some modifications. For example, loans for students pursuing higher education

should be translated to grants for parents of school children. These grants should materialize from savings made by the Ministry of Education through the streamlining of national and provincial bureaucracies, not by dipping into the Treasury debt pool.

In designing policies for higher education or school education it is important to understand what is signified by a cut-off mark for admission to State universities or to 'popular' secondary schools. The cut-off mark is an arbitrary number determined according to the number of slots available in public universities or popular secondary schools. If the cut-off Z-score for 2.1808 for the Faculty of Medicine for a student applying from the District of Colombo, it means that those getting 2.1808 or above get a 100% free of charge of education while somebody getting 2.1800 does not get any State support. Thankfully, these inequities are being addressed, slowly but surely.

### 2.9.2 Lessons from higher education

For decades a vociferous minority who gained access to free higher education and university teachers who benefited from a state monopoly situation determined that private education is evil, and the solution was to keep increasing free public opportunities. Succeeding governments have indeed increased opportunities and today the percentage of youth receiving free education at public universities is 7% of the 1824 youth cohort. What about the freedom of other 93% to pursue their aspirations with or without State assistance?

Individual freedom is enshrined in our Constitution. To be free is to be not subjected to the arbitrary will of another. Governments past have hidden behind the pipedream of free public higher education for all and allowed a silent majority to be subjected to the will of a minority opposing private education. There is no plaque to mark the first degree awarded by a private institution in this country, but the ideological opposition has been overcome, and now our youth have many private alternatives for pursuing higher education.

Freedom of choice is not just about having alternatives. The alternatives have to be affordable and the information available. The loan scheme of the present Government goes a long way in making private education more affordable. However, we need to be cognizant of the student debt trap phenomenon experienced by youth in developed countries. Addressing such concerns require more thought but the loan scheme is a necessary first step.

Missing also is an effort to make comparative information available. A simple online registration system, the data on which is accessible to the general public, is the next step. At

LIRNEasia we developed such a tool where anybody can search for private higher education opportunities by entering the desired field of study (See http://www.educationforum.lk/higher-education). The purpose of the tool was to demonstrate the concept. It is up to the Government to continue such a dash board. Cost of education and other details can be compared by prospective students, if the educational institutions are mandated by Government to make those available.

### 2.9.3 School education

Meeting the demand for a quality school education is another burning issue. For example, there are close to 200 international schools in the country serving the needs of parents who have not been served by public sector. Yet, these private providers are met with hostility. If the Ceylon Teachers' Union (CTU) has its way, private schools will have no place in school education and they should be taken over by a government which cannot manage its own. CTU is against regulating private schools citing that would give undue recognition to these schools. On the other hand, the Child Protection Authority says they receive complains about mistreatment of children in private schools and they insist on regulation. The tone of the Authority is hostile. The CTU is repeating self-serving slogans and the Authority is singling out private institutions.

The attitude to private education is similar across the spectrum from school education to higher education. Either private education is seen as inherently evil or inherently of low quality. There are good reasons for regulating private education but not based on false assumptions such as these.

**'Popular' public schools provide only ~16,000 opportunities for 355,000 aspirants**

Not all 355,000 or so students sitting for the Grade V Scholarship exam possess superior cognitive abilities, but to parents, their child is special and they aspire for the best for them. The present Government and governments past have made efforts to make the neighborhood schools attractive, but there will always be some schools that are more popular than others. To the Government's credit the number of these sought-after schools have increased from 107 in 2007 to 186 in 2022, but there are serious inequities in awarding spots in a popular school.

For example, a majority of the places in these 'popular' schools are already filled by students admitted to Grade 1 using miscellaneous criteria including past pupil status of parents and proximity evidence which may or may not be true. It is not the intention of this article to critique these admission practices because these schools are probably popular because of the presence of more privileged persons of society who have used their privilege to secure places beginning in Grade One. The purpose here is to note that quality public options for parents are severely limited.

The 186 or so 'popular schools' create one to three new classes worth of new slots in the Sixth Grades every year to make room for admissions based on Grade Five scholarship results. For example, Royal College of Colombo may have 10 or more parallel classes in Grade 6, but according to Ministry of Education sources, only three class equivalents are open to scholarship students; Maliyadeva College in Kurunegala, for example, offers two classes and Dharmaraja College in Kandy offers only one new class for scholarship students.

In 2022, 86 schools made available three new classes, 69 schools availed two new classes and 36 schools availed only one new class, in the Sinhala medium. If we assume that a class in a popular school is typically packed with about 50 students, the maximum number of slots available for Sinhala medium scholarship recipients is about 16,000.

Similar to the case of higher education, the cut-off mark for admission to these schools is determined by the number of slots available. In 2022, a student needed to score 93.5% or more to secure a place in Royal College and 94.5% for Visakha Vidyalaya. Other schools require lesser scores. If you lived in a Hatton, for example, you needed 81% or more to secure a place in Handunuwewa Central College, a Sinhala medium school. What if your child received 80% and you believe that other schools in Hatton do not provide the education you wish for your child? If the Ceylon Teachers Union or anti-private education activists have their way, the parents of the rest of the children should just make do.

**International schools provide ~12,000 or more opportunities**

Mercifully, parents have private options. There are 34 historical private schools, including Musaeus College, S. Thomas' College and Trinity College, which were allowed to remain independent and unaffected by the takeover of schools in 1961. There is a further set of

46 assisted private schools including St. Joseph's College, Wesley College and Carey College, which continue to receive State assistance but are managed by independent boards. Additionally, there are now 200 or more international school s that have emerged, having bypassed the archaic law of 1961 that prohibits setting up private schools. The total of private options now exceeds 280. Parents have voted with their feet to validate these institutions and the clock cannot be turned back. Twenty-five of the international schools have organized themselves as The International Schools of Sri Lanka (TISSL) and they claim to enroll 40,000 or more students or roughly 3,100 entrants per year to those schools. If we make the modest estimate that each of the other ~175 international schools enroll 50 students per year on average, international schools together provide an additional 12,000 slots for new entrants per year. (We did not count historical private schools because admissions to those may not be as open as admissions to international schools).

### 2.9.4 Light-touch regulation and scholarships to support

Parents need some guidance in selecting from among these private options, but command and control regulation can do more harm than good. Unfortunately, our politicians and bureaucrats only know how to issue circulars. There is no follow-up and they don't care about cost of compliance and adverse impacts.

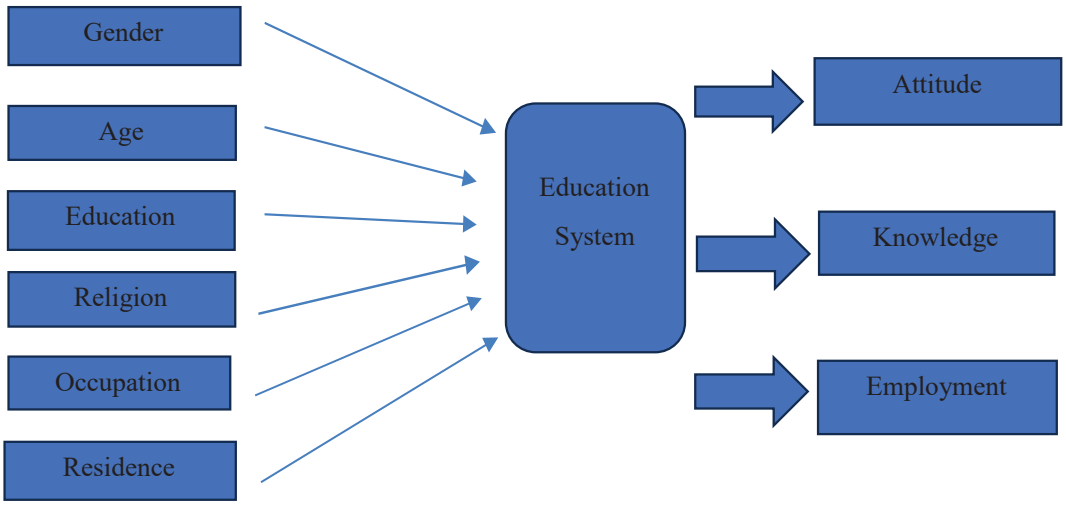
Open data is the modern approach to regulation. As in the case of higher education, the Government should require all private institutions to upload comparable data on facilities, qualifications of teachers and past success of students at examinations on to a public website which contains tools for anybody to compare and contrast available opportunities in terms the attributes they value. The Ministry of Education does not need an army of inspectors to monitor. Thousands of eyeballs can impose self-regulation on contributing institutions. Self-regulation through open data is better than the discretionary judgment of inspectors who may or may not be swayed by graft.

In cases where the international schools fill gaps in public education opportunities, scholarships should be provided to students to attend these institutions. Students who do well at the scholarship exam but fail to secure a public school of their choice should be the first to benefit. In some public schools, no matter how much money the Government pours into the system, structural and cultural barriers prevent them from performing. In such a

scenario, if there is a higher performing private school in the vicinity, it would serve the public interest better if the students are awarded scholarships to attend the private alternative.

Plush facilities or qualified teachers do not necessarily provide a good education environment. I've seen private institutions operating with shoe-string budgets providing a student-centered education which none of our popular schools can say they provide. Do not be misled by appearances. Some of our best schools started as mud-huts.

### 2.9.5 Conceptional framework




## 3. Methodology

Research design is the framework that has been created to seek answers to research question. The function of the research design is to ensure that the evidence obtained enable you to effectively address the research problem logically and as unambiguously as possible. And the set of methods and procedures used in collecting and analyzing measures of the variables specified in the research problem.

The main purpose of this chapter to explain the ways and methods used to carry out the research. In here separately identified independent and dependent variables. Through this chapter, it is explained step by step how the research is being conducted including research design, sampling, operationalization, development measurement scale and the questionnaire and validation of measurement properties.

## 3.1 Research Design

### 3.1.1 Purpose of the Study

The main objective of this research to Find out, what are the major issues or challenges faced by the international schools and ways to overcome those issues.

There are two types of research methodologies exploratory research and descriptive research.

According to, the purpose of this research it can be categorized as descriptive research methodology.as main purpose of this research is to describe the characteristics of the variable. Because exploratory research is also necessary when some facts are known but more information is needed for developing a viable theoretical framework.

The goal of a descriptive study, therefore is to offer to the researcher a profile or to describe relevant aspects of the phenomenon of interest from an individual, organizational, industry oriented or other perspective.

Descriptive studies that present data helpful to Understand the characteristics of a group in given situation, think systematically about aspects in each situation, offer ideas for further probe and research and help make certain simple decisions. Under descriptive methodology survey and questionnaire are used as tools to collect data.

### 3.1.2 Extent of Researcher Interference

The extent of interference by the researcher with the normal flow of work in the workplace has a direct bearing on whether the study undertaken is casual or correlational. A correlational study is conducted in the natural environment of the organization with minimal interference. By developing a theoretical framework, collected relevant data and analyze them to take conclusion.

This research is conducted within international school student's parents with minimum level of interference. Required data for the evaluation will be gathered through the already developed questionnaire and normal activities are not interfered.

Respondent give total freedom to answer those questions and express their own view. Respondent able to express their opinion with a minimal level interference.

### 3.1.3 Study Setting

Study setting can be field study, field experiment or lab experiment. This research is conducted in the natural environment where everything proceeds in normally. Respondent can give their answers without any influence.

As this study is carried in non-contrived setting. But in here respondent can do any manipulations in answers by giving false information. Respondents were approached in their Places. And, one respondent approach only at one time.

### 3.1.4 Unit of Analysis

The unit of analysis refers to the level of aggregation of the data collected during the subsequent data analysis stage. (Sekaran,2010) It means the population that the research is conducted. This research is conducted by selecting parents who represent the Trincomalee district. For this purpose, data, will have to be collected from each individual young people. And the unit of analysis is the individual.

### 3.1.5 Time Horizon

Time horizon can be cross-sectional or longitudinal. This research will be conducted using single cross- sectional design under descriptive method. By using this method, we collect required data from any given sample only at once.

That means one-shot data collection method. Furthermore, we collect this information with in the same time. Only one sample of respondent will be considered from the target population. Make sure to receive only one questionnaire for each respondent.so there are no repetitive response.

### 3.1.6 Sample Design

The Process of selecting the right individuals, objects, or events as representative for the entire population is known as sampling. The main purpose of this sample design is to describe the entire target population, sample, and sampling technique and sample size.

This research is conducted by using non-probability sampling. In non-probability sampling design, the element in the population do not have any probabilities attached to their being chosen as sample subjects. This method is used because it is convenient process to data collection.

### 3.1.7 Target Population

The population refer to the entire group of people, events, or things of interest that the researcher wishes to investigate. Parents of Trincomalee District will be used as a population.

The population of Trincomalee District is 503,480 (2012). People who represent the age between 21-30 is (53,307), 31-40 (41,754) and 41-50 (38,312) of the total population. (Census of population and housing ,2022).

### 3.1.8 Sample Techniques

Convenience sampling techniques used to collect the data for this research.

**Convenience sampling means collection of information from members of the population who are conveniently available to provide it. Questionnaire distributed among the people who lived in Trincomalee district in convenient manner.**

### 3.1.9 Sample Size

I approached 100 individuals to collect required data for research by focusing on the people who represent Trincomalee.

### 3.1.10 Sample Element

Element is a single member of the population under this study. Sample element of this study can be taken as follows, an individual who live in Trincomalee as at February 2022. This research conducted to take insight of the education development among Trincomalee people. So, that need to find individuals who live in Trincomalee.

Age between 21 to 50 years old. This research conduct to take information from young generation so we take information from individuals who represent the age between 21 and 50 years.

As they have fresh ideas and they have enough time to do something to the society. But we must ensure they have enough knowledge about the education system.

### 3.1.11 Sample Unit Set of elements

That is available to select in some stage of the sampling process. “Trincomalee District” is the sampling unit for this research.

## 3.2 Data Collection

Data collection can be done in two ways. Primary source and secondary source. Data collection through the primary source known as primary data, it means data originated by the researcher for the specific purpose of addressing the research problem.

Data collected from the secondary source known as secondary data.it means data collected for some purpose other than the problem at hand. Basically, researcher used both data to conduct the research.

### 3.2.1 Primary Data Collection

The main purpose of the primary data to identify the hidden insight of the target population. Individuals provide information when interview, administered questionnaire or observed, focus group, in-depth interview are the source of primary data. This research can be categorized as descriptive research. Therefore, it can use survey or observation to collect data.

This research basically distributed questionnaire survey to gather primary data. These data were gathered from 100 respondents via distributing questionnaire.

This included different kinds of questions such as unstructured questions and structured questions. Structured question such as open-ended questions used to take general opinion. And used some structured questions are multiple choice questions, Dichotomous questions and Scaling questions to measure the degree of the education related problems and take insight for research problem.

### 3.2.2 Secondary Data Collection

Secondary data is the data which is taken from already exist researches, articles, journal, industry analysis, media, website and books. These kinds of data provide lot of information for research and problem solving. In this research used following sources to collect secondary data. Emerald research articles and journals, Department of census and statistic data, Education related websites, Books related to international education and young generation are some of them. Information from the secondary sources used to develop the theoretical framework. And, it used to construct questionnaire and develop hypothesis.

## 3.3 Operationalization /Development of the Questionnaire and measurement scales.

### 3.3.1 Independent Variable

In this research Age, education qualification, residence, gender, occupation and religion considered as the independent variables.

### 3.3.2 Dependent variable

Solving education related problems is considered as the dependent variable for this research. To measure the dependent variable three dimensions are used. They are Knowledge, Attitude, Employment.

Knowledge- Level of general knowledge about education issues Knowledge about specific problems faced by students.

Attitudes - Attitudes towards key education related issues.

Employment – Job opportunities for students who finished their studies in international schools.

### 3.3.3 Operationalization

Operationalization is done by looking at the dimension denoted by the conceptual framework. In other word convert abstract concept in to measurable and observable is called operationalization. In here convert five dimensions in to measurable and observable using literature.

Operationalization of Education Problems.

| Construct | Dimension | Indicator | Indicator |
|---|---|---|---|
| Solving problems faced by students of international schools. | 1.Knowledge | K1-Knowledge about education system<br>K2-Students Behavior.<br>K3-Comparison with government school<br>K4-Service Provided and Satisfaction<br>K5-Language related problems | 5-point itemized scale (5=-Strongly Aware, 1=Least Aware) |
| | 2.Attitude | A1-You have enough knowledge about the current educational issues.<br>A2-Forcing of languages might affect learning talent of students.<br>A3-You are aware of different international schools and their services.<br>A4-You have knowledge about the role of money in education system<br>A5-Your knowledge about the shortage of teachers in the government schools.<br>A6-Personal awareness about the shortage of important resources in government schools A7-You believe that the public has enough | Tick the appropriate response (Strongly Agree, Agree, neither agree or disagree, Disagree, strongly disagree) |
| | | information regarding the current education related issues. | |

| | | | |
|---|---|---|---|
| | 3.Employment | EA1-Join and support education awareness programs.<br>EA2-Public involvement in Compliance Monitoring of education.<br>EA3-Educating community and leaders.<br>EA4-Use of print, broadcast and internet media.<br>EA5-Campaigns targeted to specific population/groups (showing people how the problem would affect them or their lifestyle). EA6-Encourage international schools to develop public welfare actions. EA7-Incorporating about international schools in the basic education curriculum. | 5-point itemized scale 5 = "Very important', 1 = "Least important" |

### 3.4 Construction of Questionnaire

- The first part of the questionnaire included demographic data. (Age, gender, Education, occupation, religion and Residence.)
- The second part of the questionnaire design to measure the **Educational Problems** by using **Tick the appropriate response scale**. This part of the questionnaire included the question which measure the **attitude** of respondents.
- The third part of the questionnaire design to measure the educational problems by using **5-point Likert scale**. This part of the questionnaire included the question which measure the **knowledge** and **Employment opportunities** for respondents.

### 3.5 Measurement and Measures

Reliability and validity test are associate with measurements. Reliability and validity were evaluated based on questionnaire.

### 3.5.1 Reliability

Reliability consists of two parts. They are stability and internal consistency. Stability refers to the ability of a measure to remain the same over time. It involves administering forms of the scale on two or more different occasions. Internal consistency refer can be estimated from the administration of the scale at a single time. Internal consistency is indicative of the homogeneity of the items in the measure that tap the construct.

This can be seen by examining if the items and the subsets of items in the measuring instrument are correlated highly. Coefficient alpha (Cronbach's alpha) is a commonly used internal consistency measurement.

In this research, Cronbach's Alpha has been used to measure the reliability of the items. The Cronbach's Alpha is the most commonly used measure for evaluating the reliability of survey instruments.

A Cornbach's Alpha of around 0.70 is normally acceptable in exploratory research; (Robert & Wortzel, 1979) suggest that a Cronbach's Alpha of between 0.70and 0.98 is "highly reliable", and that anything below 0.35 should be rejected.

### 3.5.2 Validity

Validity can be defined as whether the research is able to scientifically answer to the question that is intending to answer. Validity consists of construct validity and content validity. Content validity measure the degree to which the definition given by the researcher for a specific construct capture the representativeness of the domain of the construct.

**Construct validity means sufficiency of the indicator to measure the construct. It includes four types' convergent validity, Uni-dimensionality, Discriminant validity and non-logical validity.**

#### 3.5.2.1 Uni-dimensionality

In this study, Uni-dimensionality for each indicator was measured using factor analysis. The level of coefficient used for the factor loading was 0.4

#### 3.5.2.2 Content Validity

The content validity was established by carrying out a rigorous literature review and referring to literature in depth. Through literature review, questionnaire used in this research was designed with reference to the dimensional question proposed are in accordance with content validity.

Constructs used in the survey have high content validity as they were developed based on the previously published literature. Dimensions and indicators of the dependent variable and independent variables were operationalized based on the previous research works.

### 3.5.2.3 Construct Validity

Construct validity was evaluated by the convergent and discriminant validity.
Conducting a factor analysis researcher established construct validity. If Kaiser-Meyer Olkin measure of sampling adequacy is above 0.5 and if the level of significance is below 0.05, a factor analysis could be carried out. Under factor analysis Average Variance Extracted (AVE) should be greater than o.5 (Ha & Jang, 2012). The composite reliability should be greater than 0.5 to accept the dimension.

## 3.6 Data Analysis and Findings

### 3.6.1 Chapter Introduction

This chapter provides the analysis of data gathered from the survey as primary data. This data analysis mainly focused on illustrating the insight of the collected data and addresses the research problem to achieve the research objectives.

The analysis explains the demographic information of the sample and descriptive analysis method is used to classify the characteristics of the sample. Further, ANOVA and one Sample t -test analysis performed to test the hypotheses. Finally, this chapter directs to draw an overall conclusion about this study and explained the research findings.

### 3.6.2 Analysis of the sample profile

Questionnaires were administered by distributing hard copies. 100 questionnaires were distributed by the researcher and all the 100 questionnaires were responded by the respondents. Those 100 questionnaires are not consisting any missing value or invalid response.

### 3.6.3 Analysis of demographic variables

**Statistics**

| | Gender | Age | Education | Religion | Occupation | Residence |
|---|---|---|---|---|---|---|

| | | | | | | |
|---|---|---|---|---|---|---|
| N Valid | 100 | 100 | 100 | 100 | 100 | 100 |
| Missing | 0 | 0 | 0 | 0 | 0 | 0 |
| Mean | 1.40 | 2.14 | 2.59 | 1.87 | 3.06 | 1.86 |
| Median | 1.00 | 2.00 | 2.00 | 2.00 | 3.50 | 2.00 |
| Mode | 1 | 2 | 1 | 1 | 4 | 2 |
| Std. Deviation | .492 | .725 | 1.386 | .884 | 1.090 | .725 |
| Variance | .242 | .526 | 1.921 | .781 | 1.188 | .526 |

Source: Survey Data

### 3.6.3.1 Gender Categorization of Respondents

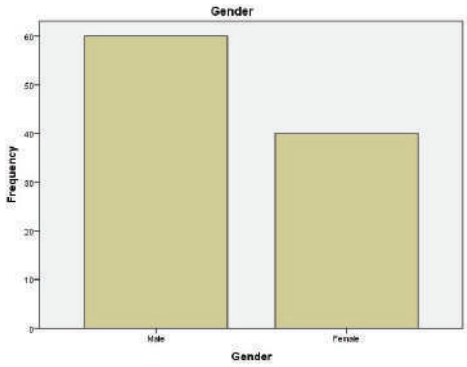
**Statistics**

**Gender**

| | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|
| Valid Male | 60 | 60.0 | 60.0 | 60.0 |
| Female | 40 | 40.0 | 40.0 | 100.0 |
| Total | 100 | 100.0 | 100.0 | |

Source: Survey Data

According to the Table (60%) respondents were male and (40%) respondents were female. A better graphical representation of these percentages is shown in figure



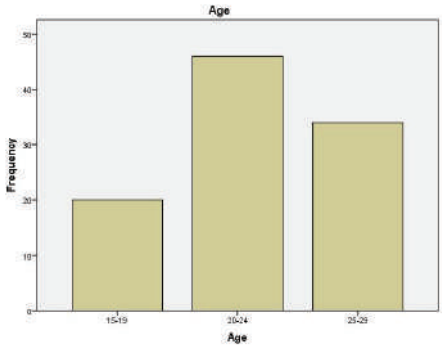
### 3.6.3.2 Age Categorization of Respondents Statistics

**Age**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | 21-30 | 20 | 20.0 | 20.0 | 20.0 |
| | 31-40 | 46 | 46.0 | 46.0 | 66.0 |
| | 41-50 | 34 | 34.0 | 34.0 | 100.0 |
| | Total | 100 | 100.0 | 100.0 | |

Source: Survey Data

According to this table When identifying the Age level of the respondents, a higher percentage 46% goes to the age 21-30. The second highest response rate 34% can be identified in age 31-40 category and Another 20% of the respondents represent age 4150 category. A better graphical representation of these percentages is shown in figure




### 3.6.3.3 Education Categorization of respondent

### Statistics

This Question was used by the researcher to gather information regarding the level of education of the respondents.

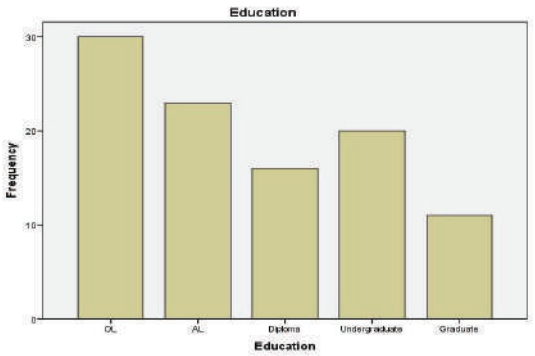
Within the Trincomalee context, we could divide the education levels mainly into five categories. For each of the education levels the following statistical observations were obtained. The values are shown in the Table.

**Education**

| | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|
| Valid OL | 30 | 30.0 | 30.0 | 30.0 |
| AL | 23 | 23.0 | 23.0 | 53.0 |
| Diploma | 16 | 16.0 | 16.0 | 69.0 |
| Undergraduate | 20 | 20.0 | 20.0 | 89.0 |
| Graduate | 11 | 11.0 | 11.0 | 100.0 |
| Total | 100 | 100.0 | 100.0 | |

Source: Survey Data

When identifying the education level of the respondent higher percentage (30%) goes to the O/L. The second highest response rate can be identified as A/L category with a percentage of (23%). A better graphical representation of these percentages is shown in figure



### 3.6.3.4 Religious Categorization of the respondents

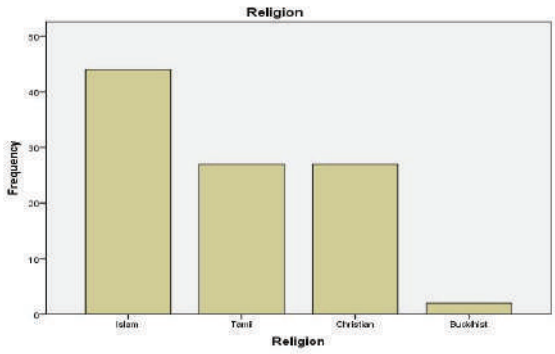
**Statistics**

**Religion**

| | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|
| Valid Islam | 44 | 44.0 | 44.0 | 44.0 |
| Tamil | 27 | 27.0 | 27.0 | 71.0 |
| Christian | 27 | 27.0 | 27.0 | 98.0 |
| Buddhist | 2 | 2.0 | 2.0 | 100.0 |
| Total | 100 | 100.0 | 100.0 | |

Source: Survey Data

When identifying the religion of the respondents, a higher percentage (44%) goes to the Islam. The second highest response rate can be identified as Hindu and Christian category with a percentage of 27%. 2% of the respondents represent Buddhist. A better graphical representation of these percentages is shown in figure




### 3.6.3.5 Occupation Categorization of respondents

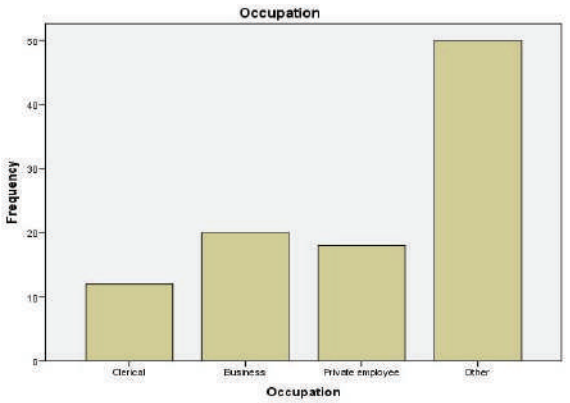
**Statistics**

**Occupation**

| | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|
| Valid Clerical | 12 | 12.0 | 12.0 | 12.0 |
| Business | 20 | 20.0 | 20.0 | 32.0 |
| Private employee | 18 | 18.0 | 18.0 | 50.0 |
| Other | 50 | 50.0 | 50.0 | 100.0 |
| Total | 100 | 100.0 | 100.0 | |

Source: Survey Data

When identifying the occupation of the respondents, a higher percentage (50%) goes to the other (students). The second highest response rate can be identified as other business as 20%. And 18% belongs to the private employee and 12% clerical workers. A better graphical representation of these percentages is shown in figure




### 3.6.3.6 Residence Categorization of respondents

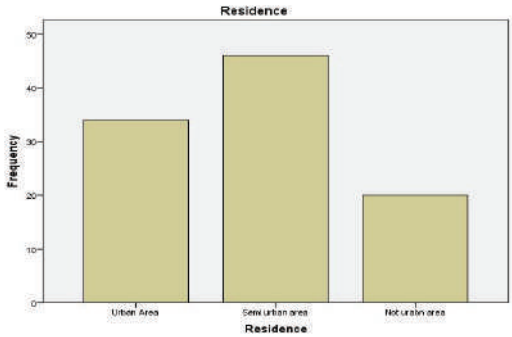
**Statistics**

**Residence**

| | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|
| Valid Urban Area | 34 | 34.0 | 34.0 | 34.0 |
| Semi urban area | 46 | 46.0 | 46.0 | 80.0 |
| Not urban area | 20 | 20.0 | 20.0 | 100.0 |
| Total | 100 | 100.0 | 100.0 | |

Source: Survey Data

When identifying the residence of the respondents, a higher percentage (46%) goes to the semi urban area. The second highest response rate can be identified as urban area (34%) and the not urban area category with a percentage of (20%). The values are shown in this Figure.




### 3.6.4 Analysis of validity and reliability Dependent Variable

#### 3.6.4.1 Uni-dimensionality

In this study, Uni-dimensionality for each indicator was measured using factor analysis. The final rotated component matrix is shown in Table.

The level of coefficient used for the factor loading was 0.4. Through the factor analysis it was evident that some of the items were highly correlated which complicates the assessment of scale validity. Therefore, the elimination of these items reduced the number of items as below.

**Descriptive Statistics**

| | Mean | Std. Deviation | Analysis N |
|---|---|---|---|
| A1 | 1.91 | .842 | 100 |
| A2 | 1.93 | .868 | 100 |
| A3 | 2.47 | 1.132 | 100 |
| A4 | 3.22 | 1.330 | 100 |
| A5 | 2.62 | 1.196 | 100 |
| A6 | 1.73 | .750 | 100 |
| A7 | 2.54 | 1.167 | 100 |
| K1 | 2.94 | 1.309 | 100 |
| K2 | 2.80 | 1.356 | 100 |
| K3 | 2.41 | 1.296 | 100 |
| K4 | 2.54 | 1.359 | 100 |
| K5 | 2.33 | 1.415 | 100 |
| EA1 | 3.18 | 1.306 | 100 |
| EA2 | 3.16 | 1.301 | 100 |
| EA3 | 3.43 | 1.328 | 100 |
| EA4 | 3.49 | 1.374 | 100 |
| EA5 | 3.61 | 1.614 | 100 |
| EA6 | 3.43 | 1.297 | 100 |
| EA7 | 3.50 | 1.439 | 100 |

Source: Survey Data

**Rotated Component Matrix**

| | Componentt | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| A1 | -.061 | -.211 | .099 | .730 | .358 |
| A2 | -.066 | .048 | -.005 | .891 | -.076 |

| | | | | | |
|---|---|---|---|---|---|
| A3 | .155 | -.242 | .528 | .347 | .444 |
| A4 | .029 | -.159 | .886 | .137 | .061 |
| A5 | -.081 | -.107 | .828 | .015 | .011 |
| A6 | .113 | -.124 | .054 | .073 | .871 |
| A7 | .280 | -.147 | .216 | .604 | .002 |
| K1 | .560 | .421 | -.065 | .097 | -.265 |
| K2 | .213 | .715 | -.210 | -.077 | -.219 |
| K3 | .307 | .854 | -.119 | -.138 | .033 |
| K4 | .360 | .836 | -.080 | -.021 | .028 |
| K5 | -.065 | .841 | -.086 | -.096 | -.138 |
| EA1 | .688 | .309 | -.355 | -.114 | .126 |
| EA2 | .688 | .334 | -.095 | .019 | -.250 |
| EA3 | .766 | .049 | .081 | .077 | .055 |
| EA4 | .836 | .099 | -.081 | -.130 | .157 |
| EA5 | .879 | .043 | .018 | -.054 | .193 |
| EA6 | .837 | .140 | -.016 | .119 | .036 |
| EA7 | .679 | .119 | .266 | .199 | -.082 |

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization. a. Rotation converged in 5 iterations.

Source: Survey Data.

## Convergent Validity

It says the degree to which the scale correlates positively with other measures of the same constructs. Its examinant any indicator highly correlates with set of indicators in a same construct.

- Kmo (Kaiser Mayor olkin) test = should be >0.5
- Bts (Bartlett's test of sphericity) = should be p<0.05 (sig value)
- Ave test (average variance extractor) = should be > 0.5

Summarized result of Convergent Validity for Education concern (Dependent variable) given in the table

| Dimension | | KMO | Bartlett's test | AVE | CR |
|---|---|---|---|---|---|

| | No. Of item | >0.5 | Sig<0.5 | Chi Square | >0.5 | >0.7 |
|---|---|---|---|---|---|---|
| Attitude | 7 | .614 | .000 | 192.670 | | |
| Knowledge | 5 | .708 | .000 | 316.049 | | |
| | | | | | | |
| Employment | 7 | .855 | .000 | 422.114 | | |

When considering the dimensions of the Education concern concept particular indicators of each dimension KMO test are greater than 0.5 and Bartlett test are significant and the CR test are >0.7 and AVE values are >0.5. It says that dimensions are met with convergent validity. Results are as follows,

**Attitude**

**KMO and Bartlett's Test**

| | | |
|---|---|---|
| Kaiser-Meyer-Olkin Measure of Sampling Adequacy. | | .614 |
| Bartlett's Test of Sphericity | Approx. Chi-Square | 192.670 |
| | df | 21 |
| | Sig. | .000 |

Source: Survey Data.

**Total Variance Explained**

| Component | Initial Eigenvalues | | | Extraction Sums of Squared Loadings | | |
|---|---|---|---|---|---|---|
| | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % |
| 1 | 2.763 | 39.469 | 39.469 | 2.763 | 39.469 | 39.469 |
| 2 | 1.333 | 19.046 | 58.515 | 1.333 | 19.046 | 58.515 |
| 3 | .997 | 14.236 | 72.751 | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 4 | .760 | 10.862 | 83.613 | | | |
| 5 | .520 | 7.434 | 91.047 | | | |
| 6 | .391 | 5.582 | 96.628 | | | |
| 7 | .236 | 3.372 | 100.000 | | | |

Extraction Method: Principal Component Analysis.

Source: Survey Data.

## Knowledge

**KMO and Bartlett's Test**

| | | |
|---|---|---|
| Kaiser-Meyer-Olkin Measure of Sampling Adequacy. | | .708 |
| Bartlett's Test of Sphericity | Approx. Chi-Square | 316.049 |
| | df | 10 |
| | Sig. | .000 |

Source: Survey Data.

**Total Variance Explained**

| | Initial Eigenvalues | | | Extraction Sums of Squared Loadings | | |
|---|---|---|---|---|---|---|
| Component | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % |
| 1 | 3.303 | 66.065 | 66.065 | 3.303 | 66.065 | 66.065 |
| 2 | .860 | 17.197 | 83.262 | | | |
| 3 | .493 | 9.857 | 93.120 | | | |
| 4 | .223 | 4.455 | 97.575 | | | |
| 5 | .121 | 2.425 | 100.000 | | | |

Extraction Method: Principal Component Analysis.

Source: Survey Data.

## Employment

**KMO and Bartlett's Test**

| | |
|---|---|
| Kaiser-Meyer-Olkin Measure of Sampling Adequacy. | .855 |

| | | |
|---|---|---|
| Bartlett's Test of Sphericity | Approx. Chi-Square | 422.114 |
| | df | 21 |
| | Sig. | .000 |

Source: Survey Data.

**Total Variance Explained**

| Component | Initial Eigenvalues | | | Extraction Sums of Squared Loadings | | |
|---|---|---|---|---|---|---|
| | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % |
| 1 | 4.411 | 63.008 | 63.008 | 4.411 | 63.008 | 63.008 |
| 2 | .812 | 11.602 | 74.611 | | | |
| 3 | .591 | 8.446 | 83.056 | | | |
| 4 | .480 | 6.863 | 89.920 | | | |
| 5 | .309 | 4.409 | 94.329 | | | |
| 6 | .220 | 3.149 | 97.478 | | | |
| 7 | .177 | 2.522 | 100.000 | | | |

Extraction Method: Principal Component Analysis.

Source: Survey Data.

### 3.7 Reliability

Reliability statistics of Education Concern-Dependent Variable

| Dimension | No. of items | Cronbach's alpha |
|---|---|---|
| A-Attitude | 7 | 0.733 |
| K- knowledge | 5 | 0.867 |
| EA- Employment | 7 | 0.900 |

Source: Survey Data.

Considering above dimensions of educational problems, calculated the reliability of indicators. So, the Cronbach's alpha is greater than 0.7 so educational issues can be reliable under Cronbach's alpha.

Since all these figures are greater than 0.7 which is the standard requirement to be met to be internally consistent. It can be concluded that the questionnaire used in this research is high in reliability and validity. Results are as follows,

### 3.7.1 Attitude

**Reliability Statistics**

| Cronbach's Alpha | N of Items |
|---|---|
| .733 | 7 |

Source: Survey Data.

**Item Statistics**

| | Mean | Std. Deviation | N |
|---|---|---|---|
| A1 | 1.91 | .842 | 100 |
| A2 | 1.93 | .868 | 100 |
| A3 | 2.47 | 1.132 | 100 |
| A4 | 3.22 | 1.330 | 100 |
| A5 | 2.62 | 1.196 | 100 |
| A6 | 1.73 | .750 | 100 |
| A7 | 2.54 | 1.167 | 100 |

Source: Survey Data.

**Scale Statistics**

| Mean | Variance | Std. Deviation | N of Items |
|---|---|---|---|
| 16.42 | 21.175 | 4.602 | 7 |

Source: Survey Data.

**Item-Total Statistics**

| | Scale Mean if Item Deleted | Scale Variance if Item Deleted | Corrected Item-Total Correlation | Cronbach's Alpha if Item Deleted |
|---|---|---|---|---|
| A1 | 14.51 | 16.757 | .538 | .687 |
| A2 | 14.49 | 18.131 | .310 | .729 |
| A3 | 13.95 | 14.472 | .629 | .654 |
| A4 | 13.20 | 13.677 | .582 | .665 |
| A5 | 13.80 | 15.798 | .415 | .711 |
| A6 | 14.69 | 18.842 | .272 | .735 |
| A7 | 13.88 | 16.066 | .401 | .714 |

Source: Survey Data.

### 3.7.2 Knowledge

**Reliability Statistics**

| Cronbach's Alpha | N of Items |
|---|---|
| .867 | 5 |

Source: Survey Data.

**Item Statistics**

| | Mean | Std. Deviation | N |
|---|---|---|---|
| K1 | 2.94 | 1.309 | 100 |
| K2 | 2.80 | 1.356 | 100 |
| K3 | 2.41 | 1.296 | 100 |
| K4 | 2.54 | 1.359 | 100 |
| K5 | 2.33 | 1.415 | 100 |

Source: Survey Data.

**Item-Total Statistics**

| | Scale Mean if Item Deleted | Scale Variance if Item Deleted | Corrected Item-Total Correlation | Cronbach's Alpha if Item Deleted |
|---|---|---|---|---|
| K1 | 10.08 | 21.589 | .517 | .878 |
| K2 | 10.22 | 19.406 | .699 | .836 |
| K3 | 10.61 | 18.705 | .822 | .806 |
| K4 | 10.48 | 18.192 | .824 | .803 |
| K5 | 10.69 | 19.974 | .603 | .861 |

Source: Survey Data.

**Scale Statistics**

| Mean | Variance | Std. Deviation | N of Items |
|---|---|---|---|
| 13.02 | 29.596 | 5.440 | 5 |

Source: Survey Data.

### 3.7.3 Education problem awareness

**Reliability Statistics**

| Cronbach's Alpha | N of Items |
|---|---|
| .900 | 7 |

Source: Survey Data.

**Scale Statistics**

| Mean | Variance | Std. Deviation | N of Items |
|---|---|---|---|
| 23.80 | 58.687 | 7.661 | 7 |

Source: Survey Data.

**Item Statistics**

| | Mean | Std. Deviation | N |
|---|---|---|---|
| EA1 | 3.18 | 1.306 | 100 |
| EA2 | 3.16 | 1.301 | 100 |
| EA3 | 3.43 | 1.328 | 100 |
| EA4 | 3.49 | 1.374 | 100 |
| EA5 | 3.61 | 1.614 | 100 |
| EA6 | 3.43 | 1.297 | 100 |
| EA7 | 3.50 | 1.439 | 100 |

Source: Survey Data.

**Item-Total Statistics**

| | Scale Mean if Item Deleted | Scale Variance if Item Deleted | Corrected Item-Total Correlation | Cronbach's Alpha if Item Deleted |
|---|---|---|---|---|
| EA1 | 20.62 | 45.450 | .655 | .891 |
| EA2 | 20.64 | 45.606 | .648 | .892 |
| EA3 | 20.37 | 44.660 | .691 | .887 |
| EA4 | 20.31 | 42.903 | .772 | .878 |
| EA5 | 20.19 | 39.731 | .804 | .874 |
| EA6 | 20.37 | 43.448 | .793 | .876 |
| EA7 | 20.30 | 45.040 | .599 | .898 |

Source: Survey Data.

### Discriminant validity

This measures the extent to which a measure does not correlate with other constructs from which it is supposed to differ. It says dimension should not be highly correlated with any other dimension in the same construct.

Standard- r2 should be less than or equal to AVE value. Every value is r^2 is < than AVE value so it has discriminant validity

**Attitude Correlations**

| | | Pearson Correlation | Sig. (1tailed) | N |
|---|---|---|---|---|
| A1 | A1 | 1 | | 100 |
| | A2 | .517** | .000 | 100 |
| | A3 | .458** | .000 | 100 |
| | A4 | .243** | .007 | 100 |
| | A5 | .227* | .012 | 100 |
| | A6 | .297** | .001 | 100 |
| | A7 | .358** | .000 | 100 |
| A2 | A1 | .517** 1 | .000 | 100 |
| | A2 | | | 100 |
| | A3 | .281** | .002 | 100 |
| | A4 | .084 | .204 | 100 |
| | A5 | .052 | .304 | 100 |
| | A6 | .002 | .493 | 100 |
| | A7 | .337** | .000 | 100 |
| A3 | A1 | .458** | .000 | 100 |
| | A2 | .281** | .002 | 100 |
| | A3 | 1 | | 100 |
| | A4 | .561** | .000 | 100 |
| | A5 | .357** | .000 | 100 |
| | A6 | .365** | .000 | 100 |
| | A7 | .272** | .003 | 100 |
| A4 | A1 | .243** | .007 | 100 |
| | A2 | .084 | .204 | 100 |
| | A3 | | .000 | 100 |

| | | | | |
|---|---|---|---|---|
| | A4 | .561** | | 100 |
| | A5 | 1 .618** | .000 | 100 |
| | A6 | .121 | .115 | 100 |
| | A7 | .352** | .000 | 100 |
| A5 | A1 | .227* | .012 | 100 |
| | A2 | .052 | .304 | 100 |
| | A3 | .357** | .000 | 100 |
| | A4 | .618** | .000 | 100 |
| | A5 | 1 | | 100 |
| | A6 | .121 | .115 | 100 |
| | A7 | .083 | .205 | 100 |
| A6 | A1 | .297** | .001 | 100 |
| | A2 | .002 | .493 | 100 |
| | A3 | .365** | .000 | 100 |
| | A4 | .121 | .115 | 100 |
| | A5 | .121 | .115 | 100 |
| | A6 | 1 | | 100 |
| | A7 | .180* | .037 | 100 |
| A7 | A1 | .358** | .000 | 100 |
| | A2 | .337** | .000 | 100 |
| | A3 | .272** | .003 | 100 |
| | A4 | .352** | .000 | 100 |
| | A5 | .083 | .205 | 100 |
| | A6 | .180* | .037 | 100 |
| | A7 | 1 | | 100 |

**. Correlation is significant at the 0.01 level (1tailed).

*. Correlation is significant at the 0.05 level (1tailed).

Source: Survey Data.

**Knowledge**

**Correlations**

| | | K1 | K2 | K3 | K4 | K5 |
|---|---|---|---|---|---|---|
| K1 | Pearson Correlation | 1 | .579** | .485** | .552** | .169* |
| | Sig. (1-tailed) | | .000 | .000 | .000 | .046 |
| | N | 100 | 100 | 100 | 100 | 100 |
| K2 | Pearson Correlation | .579** | 1 | .599** | .564** | .551** |
| | Sig. (1-tailed) | .000 | | .000 | .000 | .000 |
| | N | 100 | 100 | 100 | 100 | 100 |
| K3 | Pearson Correlation | .485** | .599** | 1 | .865** | .658** |
| | Sig. (1-tailed) | .000 | .000 | | .000 | .000 |
| | N | 100 | 100 | 100 | 100 | 100 |
| K4 | Pearson Correlation | .552** | .564** | .865** | 1 | .642** |
| | Sig. (1-tailed) | .000 | .000 | .000 | | .000 |
| | N | 100 | 100 | 100 | 100 | 100 |
| K5 | Pearson Correlation | .169* | .551** | .658** | .642** | 1 |
| | Sig. (1-tailed) | .046 | .000 | .000 | .000 | |
| | N | 100 | 100 | 100 | 100 | 100 |

**. Correlation is significant at the 0.01 level (1-tailed).

*. Correlation is significant at the 0.05 level (1-tailed).

Source: Survey Data.

**Education Problems Awareness**

**Correlations**

| | | Pearson Correlation | Sig. (1tailed) | N |
|---|---|---|---|---|
| EA1 | EA1 | 1 | | 100 |
| | EA2 | .631** | .000 | 100 |
| | EA3 | .520** | .000 | 100 |
| | EA4 | .643** | .000 | 100 |
| | EA5 | .556** | .000 | 100 |
| | EA6 | .515** | .000 | 100 |
| | EA7 | .317** | .001 | 100 |
| EA2 | EA1 | .631** 1 | .000 | 100 |
| | EA2 | | | 100 |
| | EA3 | .556** | .000 | 100 |
| | EA4 | .521** | .000 | 100 |
| | EA5 | .492** | .000 | 100 |
| | EA6 | .528** | .000 | 100 |
| | EA7 | .432** | .000 | 100 |
| EA3 | EA1 | .520** | .000 | 100 |
| | EA2 | .556** | .000 | 100 |
| | EA3 | 1 | | 100 |
| | EA4 | .575** | .000 | 100 |
| | EA5 | .640** | .000 | 100 |
| | EA6 | .519** | .000 | 100 |
| | EA7 | .500** | .000 | 100 |
| EA4 | EA1 | .643** | .000 | 100 |
| | EA2 | .521** | .000 | 100 |
| | EA3 | .575** 1 | .000 | 100 |
| | EA4 | | | 100 |

| | | | | |
|---|---|---|---|---|
| | EA5 | .761** | .000 | 100 |
| | EA6 | .702** | .000 | 100 |
| | EA7 | .442** | .000 | 100 |
| EA5 | EA1 | .556** | .000 | 100 |
| | EA2 | .492** | .000 | 100 |
| | EA3 | .640** | .000 | 100 |
| | EA4 | .761** | .000 | 100 |
| | EA5 | 1 | | 100 |
| | EA6 | .771** | .000 | 100 |
| | EA7 | .559** | .000 | 100 |
| EA6 | EA1 | .515** | .000 | 100 |
| | EA2 | .528** | .000 | 100 |
| | EA3 | .519** | .000 | 100 |
| | EA4 | .702** | .000 | 100 |
| | EA5 | .771** | .000 | 100 |
| | EA6 | 1 .674** | | 100 |
| | EA7 | | .000 | 100 |
| EA7 | EA1 | .317** | .001 | 100 |
| | EA2 | .432** | .000 | 100 |
| | EA3 | .500** | .000 | 100 |
| | EA4 | .442** | .000 | 100 |
| | EA5 | .559** | .000 | 100 |
| | EA6 | .674** 1 | .000 | 100 |
| | EA7 | | | 100 |

**. Correlation is significant at the 0.01 level (1tailed).

## 4.Conclusion

In my point of view, steps should be taken for better integration. And, government policies that need to be put forward or changed in order to address the needs of international school students. Everyone wants to believe that no single philosophy will guide decisions about

schools and curriculum. Curriculum planners have to help for improving school practices in harmony with history of curriculum and philosophy of the school and community. We all know that education is the most important thing which has to be neutral. If we make these changes, it will help the students to nourish the thought in the mind of the humans and make ways for the better future.

Instead of expecting internationals schools to teach in the mother tongue of the students, it's always better to move on with the world. In the current world the English language already started the domination and the students who completes the studies in native language will struggle to compete in the world with globalization. Therefore, it's better for government schools to teach the students in the English language too. And the international schools should think about the fees obtained by them from the students, because that is one of the most common criticisms kept on them and that's 100% agreeable too. Competitions are always crucial for the development, but the competitions in between the international schools exceeded the limits and they've started to destroy the names of each other. On the other hand, government schools are in the quite opposite of stage of international schools, there is no competition in between them, it led to the reduction of the pass levels of the students. Therefore, for both government and international schools a healthy competition is necessary to succeed.

And Government should make amendments for the intake of international school students into the Government universities. So, it will help the international school students to get a better and free higher education.

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# FACTORS AFFECTING THE JOB ENGAGEMENT OF TEACHERS IN GOVERNMENT SCHOOLS IN SRI LANKA: WITH SPECIAL REFERENCE TO THE NATIONAL SCHOOL TEACHERS IN THE TRINCOMALEE DISTRICT IN EASTERN PROVINCE

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## Abstract

It is well accepted that teachers' willful engagement in their jobs is a key determinant of the performance of the students, the school, and the nation. Therefore, the aim of this study is to analyze factors that have an effect on teachers' job engagement in the context of government national schools in Sri Lanka. This study uses a self-administered questionnaire survey, and the statistical technique includes multiple linear regression to investigate the effect of 17 factors that were identified as important through the literature. The results suggested that out of 17 factors, six have a significant positive effect on the teachers' job engagement. The rest of the factors also have effects, but those are statistically insignificant. This will fill the empirical vacuum in the context of Sri Lanka and add to the broader array of education and engagement knowledge. This study will be instrumental for both school-level management and leaders as well as national-level policymakers to improve the effectiveness of pedagogy.

**Keywords:** Job engagement, Factors, Teachers effectiveness**,** Teachers' engagement

## 1. Introduction

The mission of teaching is to improve the education of children and that requires teachers to invest physically, emotionally, and cognitively in their work (Choochom, 2016). Therefore, teachers have been identified as a crucial factor that can determine student performance and a factor that determines teachers' job engagement is important. Saucier et al. (2022) explain that teachers' subjective experiences ultimately impact the performance of their students. This pertains to teachers' job engagement, which is described as a favorable and satisfying mental state related to work, encompassing vigour, commitment, and deep involvement.

At present, teacher engagement is an emerging topic in education research. Understanding teacher engagement is critical to understanding the psychological processes underlying effective teaching (Klassen et al., 2013). Research suggests that teachers' job engagement positively relates to student performance, particularly in European contexts. However, there is limited research specifically related to teacher engagement in different contexts (Valenta, 2010). The education sector is vastly different from the business sectors, and therefore, requires specific studies. Regarding the Sri Lankan context, there appears to be a scarcity of research on teachers' engagement. Hence, this research holds significance and will offer various advantages from both management and academic viewpoints. It's not just teachers

who gain from heightened passion for their professions; elevated teacher engagement results in favourable effects across districts and zones, benefiting school communities, student performance, teacher contentment, and teacher retention.

GCE (OL) is the main hurdle for students in terms of pursuing higher education in the Sri Lankan context. Annually, around 40% of the students fail GCE (OL) in Sri Lanka. This is a concern of both policymakers as well as the public. Therefore, it is important to understand the current level of teacher engagement and determine what factors affect curtailment for devising strategies and policies for the education sector, especially within Sri Lanka. The unavailability of empirical and theoretical studies about factors affecting teachers' engagement is a major drawback for developing pragmatic policies and strategies in the context of Sri Lanka. It is also observable that those studies that focus on teachers' engagement in government national schools of Sri Lanka are very rare. Therefore, this study focuses on investigating factors that have a significant impact on teachers' engagement in the context of Sri Lanka using the job demand-resource model. As a result, the main purpose of this study is to determine the factors affecting the job engagement of teachers in government national schools with special reference to the Trincomalee district in the Eastern province of Sri Lanka.

## 2. Methodology

This is mainly a quantitative research approach. The administration of a questionnaire (a survey) gathered primary data for this study, and analysis was conducted using statistical techniques as a result. To gather primary data, survey forms were distributed to the respondents through an online questionnaire from the respondents. The use of a 5-point Likert scale with numbers ranging from 1 to 5 for the data collection process results in interval data. Secondary data was collected through the annual school census reports, papers in reputed journals, published research articles, publications of the Ministry of Education in Sri Lanka, and so on.

The researcher has chosen one district, called "Trincomalee district," out of five districts in the Eastern province of Sri Lanka. The Trincomalee district has 313 national and provincial schools. The researcher chooses only national schools (12) for research from among them because the national schools are funded and managed by the central government's Ministry of Education. The local provincial council governs the rest of the other schools that are considered provincial schools (301). According to GCE (OL) examination results in 2021, Trincomalee district has the lowest level of GCE (OL) results in the Eastern province, which is the key outcome of the level of teachers' engagement according to literature. Basic data for the Trincomalee district in the Eastern province are presented in Table 1.

**Table 1.** Basic Data for Trincomalee District in the Eastern Province of Sri Lanka.

| Category | National schools | Provincial schools | Total |
|---|---|---|---|
| Total number of schools | 12 | 301 | **313** |
| Total number of students | 18,260 | 78,144 | **96,404** |
| Total number of teachers | 919 | 4,521 | **5,440** |
| Sample from national school teachers (20%) | **185** | | |

Source: Annual School Census - 2021, Ministry of Education, Sri Lanka

For descriptive statistics, mainly mean, stranded deviation and correlation statistics have been used. The data were analyzed and displayed using diagrams, graphs, and charts to support realizing the outcomes of the survey. Figure 1 depicts the predicted directions of the relationships and the impacts of the factors concerning the relationships and their impacts. Accordingly, it is assumed that 17 independent factors have direct impacts on teachers' job engagement.

The conceptual framework, which was developed with the support of theories and literature on teachers' job engagement, consists of 17 independent factors and one dependent variable. Accordingly, 17 hypotheses were developed. The purified questionnaire was administered to 185 teachers (20%) who are teaching in all grades in national schools, out of the entire working population (919). Using the random sampling method, a questionnaire was distributed to 185 teachers (20%) from among them, and finally, 181 (98%) completed responses were received.

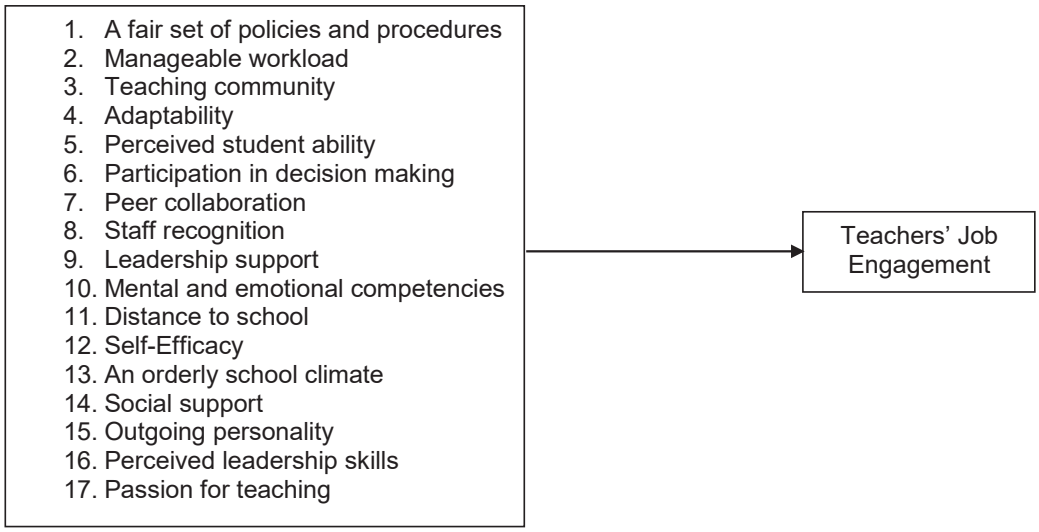


Figure 1. Conceptual Framework

## 3. Results and Discussion

Recognizing this research gap and its significance for both policymakers and educational professionals, this study was conducted to examine the effects of several factors on Sri Lankan teachers' job engagement. A review of literature revealed the identification of 17 factors, encompassing elements such as a fair set of policies and procedures, a manageable workload, teaching community, adaptability, perceived abilities of the student, participation in decision-making, peer collaboration, staff recognition, supportive leadership, mental and emotional competencies, the distance to school, self-efficacy, orderly school environment, social support, outgoing personality, perceived leadership skills, and passion for teaching.

The coefficient value (Beta) and significant value (p) presented in Table 2 for understanding how much an exogenous (independent) latent variable contributes to the variance of an endogenous (dependent) variable. According to the coefficient table shows in Table 2, this study identified and tested 17 factors that could have an effect on Teachers' job engagement.

Out of 17, six factors (H12 to H17) were having significant effects on teachers' job engagement. namely mental and emotional competencies, peer collaboration, passion for teaching, participation in decision-making, social support and outgoing personality have a significant effect on the teachers' job engagement. Reset of eleven factors (H1 to H11) has very small effects on teachers' job engagement, but these are not statistically significant. Consequently, other 11 factors, namely, a fair set of policies and procedures, a manageable workload, teaching community, adaptability, perceived abilities of the student, staff recognition, leadership support, the distance to school, self-efficacy, an orderly school environment, and, perceived leadership skills, had no significant effect on the teachers' job engagement.

**Table 2.** Co-efficient Table

| Model | | Unstandardised Coefficients | | Standardised Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | .527 | .169 | | 3.129 | .002 |
| | Fair set of policies and procedures | -.018 | .054 | -.026 | -.332 | .740 |
| | Manageable Workload | -.004 | .046 | -.008 | -.094 | .925 |
| | Teaching community | .002 | .068 | .003 | .036 | .972 |
| | Adaptability | .015 | .038 | .034 | .388 | .698 |
| | Perceived student abilities | .037 | .051 | .060 | .715 | .476 |
| | Staff recognition | .017 | .055 | .028 | .300 | .764 |
| | Leadership support | -.039 | .076 | -.053 | -.509 | .612 |
| | Distance to school | .007 | .023 | .020 | .309 | .758 |
| | Self-Efficacy | .047 | .060 | .058 | .788 | .432 |
| | An orderly school climate | -.049 | .055 | -.071 | -.896 | .371 |
| | Perceived leadership skills | .064 | .057 | .087 | 1.120 | .264 |
| | **Outgoing personality** | .065 | .017 | .092 | 3.814 | .000 |
| | **Social support** | .071 | .017 | .101 | 4.388 | .003 |
| | **Passion for teaching** | .213 | .021 | .261 | 10.588 | .000 |
| | **Participation in decision-making** | .048 | .017 | .075 | 3.013 | .000 |
| | **Peer collaboration** | .044 | .016 | .069 | 2.897 | .007 |
| | **Mental and emotional competencies** | .309 | .066 | .370 | 4.665 | .000 |

Therefore, the corresponding six hypotheses are accepted, and the other 11 hypotheses are rejected. The impact of individual factors on the teachers' job engagement based on the Beta value has been presented in Figure 2 below for easy understanding. Mental and emotional competencies have a higher level of effect on the dependent variable, and it has a (0.370) Beta value. Peer collaboration (0.150), passion for teaching (0.127), participation in decision-making (0.142), social support (0.116), and outgoing personality (0.109) have medium-level effects, according to Cohen (1992).

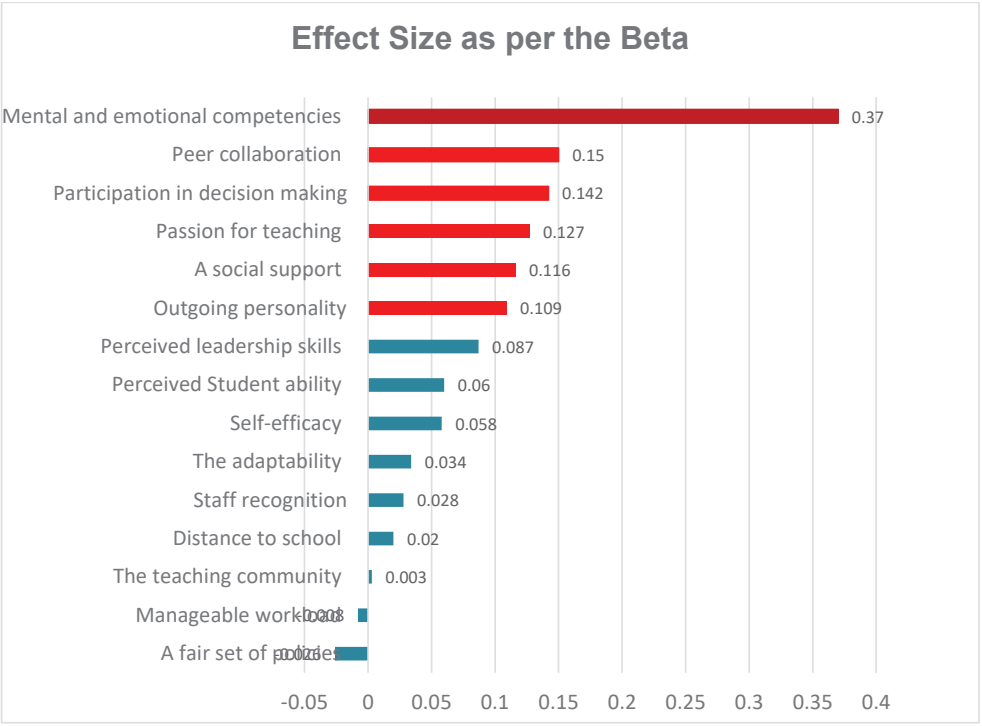


Figure 2. The impact of individual factors on the teachers' job engagement

## 4. Conclusions

Teachers' job engagement is considered to be an important concept in education management because engaged teachers can have a significant positive effect on the performance of students and the school. As there is a lack of studies in the area of factors affecting teachers' job engagement, particularly in the context of Sri Lanka, the present study focused on investigating the factors affecting the job engagement of teachers in government national schools, focusing on the Trincomalee district in the Eastern province. 17 factors were identified as independent factors through a literature review. Six of the 17 factors have a positive and significant effect on teachers' job engagement, according to the study's findings. The other 11 factors also have an effect but those are statistically insignificant. Therefore, this study has addressed the objectives, answered the research question, and added to the understanding of factors affecting teachers' job engagement.

The findings of this research are of considerable importance for teachers, school management, policymakers, and the broader education community as well. Teachers are not the only ones who benefit from increased enthusiasm for their careers but also high levels of teacher engagement lead to positive outcomes for school communities, student achievement, teacher satisfaction, and teacher retention. Although there is an impact of curriculum and technology on the learning-teaching process, teachers' own engagement is the key to high levels of student achievement. This investigation has revealed that mental and emotional competencies exert the most substantial influence on teachers' job engagement. Job-engaged teachers who deliver quality education such as seeking out new ideas and best teaching practices, frequently monitoring student progress and providing feedback, and modifying their instruction to meet

the needs of students, are achieving sustainable and achievable goals. These efforts have a direct impact on overall school performance and guide students toward meaningful career paths.

Education professionals and policymakers can clearly decide where their attention should be directed by focusing on factors affecting teachers' job engagement. To generalize the findings of a single province to other provinces, the researcher can find available data and studies from other provinces in Sri Lanka to identify similarities and differences in factors influencing teacher job engagement across the different provinces. Then the same statistical methods can be used to assess the significance and impact of factors affecting job engagement among teachers within the national context. As six of the 17 factors positively and significantly affect teachers' job engagement in the Eastern province, these findings can be applicable nationwide. Based on the findings, the researcher can provide the following suggestions: conducting continuous professional development opportunities tailored to teachers' needs and interests at national and provincial levels, initiating leadership development programs for school principals to enhance their skills in supporting and motivating teachers, fostering a culture in the school that values teamwork and encourages knowledge sharing, empowering teacher's autonomy in decision-making related to curriculum development, teaching methods, and assessment strategies, fostering community involvement by engaging parents, well-wishers, and volunteers in supporting teachers and school management to create a conducive learning environment in the school for increase the quality of the teaching and engagement. These suggestions can be facilitated for policymakers' understanding of the factors and make policy-level changes to the existing education system. Therefore, when the government recruits new teachers, it is better to recruit people who are committed to the teaching profession. Subsequently, it will be caused betterment for the entire education system in Sri Lanka.

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# THE CHALLENGES OF SOCIAL MEDIA MARKETING IN THE PRIVATE HIGHER EDUCATION SECTOR

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## Abstract

One of the most impactful and transformative technological developments in the 21st century has been the integration of social media into various aspects of commerce, entertainment, and education. In recent years, the field of education has experienced a significant transformation due to the emergence of social media platforms. These platforms provide distinct opportunities for private higher educational institutions to connect and interact with their target audiences, which include students, parents, and alumni. Nevertheless, effectively utilizing social media marketing within the private higher education sector presents its own unique set of challenges. Consequently, as the world of social media experiences rapid growth and revolution, fueled by widespread internet accessibility and the spread of mobile devices, it has evolved into a crucial means of connecting with a huge customer base despite geographical boundaries.

The primary aim of this research is to identify the potential challenges associated with employing social media marketing within the private higher education sector. This study is characterized as a descriptive investigation, relying on secondary data collected through a literature review. The results of this study pinpoint ten significant challenges that require attention to facilitate the successful implementation of social media marketing within the private higher education sector. This information can provide valuable insights to private higher education institutions as they strategize for their online marketing efforts and seek effective approaches to social media marketing. The insights provided in this paper are particularly relevant to decision-makers, educational leaders, and marketers who are striving to adeptly navigate these challenges within the global educational landscape. Overcoming these challenges is crucial for institutions aiming to harness the potential of social media as powerful tools for engaging with their target audiences and remaining pertinent in today's dynamic educational environment.

**Keywords:** Social media marketing, Challenges, Private higher education sector

## 1. Introduction

Social media marketing is a relatively recent concept that has gained growing attention, especially after COVID 19 outbreak. The widespread adoption of the internet and digital media has had a significant influence on the realm of education. The education sector has undergone a substantial transformation because the majority of students now actively engage with the Internet. This has a direct impact on the approach that higher education institutions and universities must adopt, utilizing online platforms and mobile devices to connect with a larger student population. Innovative private higher education institutions have recognized the importance of effectively utilizing social media marketing as a means to engage their target

audience and maintain a strong connection with them. At present the youth population has an impressive presence on social networking platforms, with over 98% of them actively participating. This is the primary motivation behind the widespread adoption of social media by educational institutions, as they seek to engage with this tech-savvy student population.

The dawn of the internet and the spread of social media platforms have given rise to a digital landscape that necessitates innovative approaches to recruitment, brand management, and student retention. While these technological advancements offer remarkable opportunities, they also pose a multitude of challenges that private higher education institutions must meet to remain competitive in an increasingly crowded and digitally driven marketplace. Therefore, Lamberton and Stephen (2016) assert that social media marketing has gained significant prominence within the education sector. Research indicates an increasing number of organizations that have already incorporated social media into their marketing strategies (Barnes, 2010; Barnes & Mattson, 2009). This trend holds for private higher education institutions, which are increasingly leveraging social media and digital platforms such as Facebook, Twitter, LinkedIn, YouTube, Instagram, podcasts, and more to promote their programs. Furthermore, the design and functionality of their websites have become crucial factors in how these educational institutions and universities present themselves to prospective students (Hanover Research, 2014).

In response to these developments, private higher education institutions and universities across the world are acknowledging the necessity of adapting to this new reality. Traditional recruitment methods and communication channels alone are no longer sufficient to effectively reach and engage the diverse and tech-savvy student population. Consequently, private higher education institutions find themselves in a complex landscape where they must strike a balance between the promises offered by digital marketing and the inherent challenges it presents.

In light of the significance of social media marketing in the private higher education sector, it becomes essential for educators, decision-makers, administrators, and marketing professionals to gain an understanding of the prevailing challenges and their potential consequences. This understanding enables institutions to formulate well-informed strategies that harness the full potential of digital and social media while also addressing risks and ensuring ethical and effective engagement. Consequently, the primary objective of this study is to examine the existing challenges of social media marketing within the private higher education sector, utilizing secondary information. The aim is to empower stakeholders in higher education to navigate this dynamic environment effectively and optimize their marketing efforts for the modern era.

## 2. Methodology

This is mainly literature review-based research. The studies that were used for this study were published in peer-reviewed journals and articles between 2015 and 2023. Search engines include Google Scholar, Emerald Insights, and Open Internet. 15 research papers were identified, and seven papers were included in this study. Five of them included primary data, while two contained secondary data. Among them are six descriptive methods, while one adopted a conclusive approach as the research design. The data was standardized through extraction and the possible challenges have been identified accordingly.

## 3. Results and Discussion

This research examined the inevitable issue of dealing with the challenges inherent in social media marketing within the landscape of higher education institutions, both in Sri Lanka and globally. While this statement may appear straightforward, even after several decades of exploring the realm of social media marketing, scholars and practitioners continue to closely examine its challenges. The imperative lies in formulating competitive strategies to navigate the evolving landscape and trends within an increasingly competitive educational market.

In the Sri Lankan context, there exists a noticeable vacuum in empirical studies about social media marketing, especially within the private higher education sector. Consequently, there is a clear need for specific investigations in this domain. Recognizing this research gap and its significance for policymakers and institutional decision-makers, this study concentrated on the assessment of social media marketing challenges within the Sri Lankan context, drawing comparisons with global counterparts. Table 01, presents a compilation of key challenges identified and summarized based on an extensive literature review related to social media marketing.

**Table 01.** Challenges identified from literature review

| S.N. | Reference of journals | Findings |
|---|---|---|
| 1 | Anderson, T., 2019.<br>Challenges and opportunities for use of social media in higher education. *Journal of learning for development*, *6*(1). | • Adoption to the younger generation.<br>• Lack of funding. |
| 2 | P. Mohammed Buhari Saleem and M.Mohamed Siddik, 2019.<br>A study on challenges of social media in higher education. | • Technological and privacy concerns.<br>• Content update. |
| 3 | Pucciarelli, F. and Kaplan, A., 2016.<br>Competition and strategy in higher education: Managing complexity and uncertainty. *Business horizons*, *59*(3), pp.311-320. | • Enhance prestige and market share.<br>• Embrace an entrepreneurial mindset.<br>• Expand interactions and value co-creation with stakeholders. |
| 4 | Altamira, M.B., Putri, K.D.A.P. and Samudra, R.M.R.T., 2023, February.<br>The Role of Creative Content in Digital Marketing Strategies in Educational Institution Social Media (Case Study: Instagram of Vocational Education Program, Universitas Indonesia).<br>In *Proceedings* (Vol. 83, No. 1, p. 62). MDPI. | • Identifying the target audience.<br>• Good and creative content. |
| 5 | Sędkowski, M., 2015.<br>Social media and universities: Challenges and opportunities. The International Journal of Social Sciences and Humanities Invention, 2(7), pp.1445-1450. | • Respond to a message or a post in a positive or negative way. |

| | | |
|---|---|---|
| 6 | Gondane, V. and Pawar, M., 2021.<br>A study on Impact of Digital Marketing Strategies on Education Sector with reference to Nagpur, India. *Ilkogretim Online*, *20*(1). | • Reach the right target group.<br>• Fast feedback. |
| 7 | Perera, C.H., Nayak, R. and Nguyen, L.T.V., 2022.<br>The impact of social media marketing and brand credibility on higher education institutes' brand equity in emerging countries. *Journal of Marketing Communications*, pp.1-26. | • Develop brand equity. |

The challenges that have been identified can be grouped into various categories, encompassing concerns related to privacy, target audience, content quality, negative feedback, resource limitations, and the diversity of platforms. In the Sri Lankan context, these challenges emerge as significant issues. It's worth noting that Sri Lanka has a relatively modest proportion of active social media users, accounting for only 30% (Hootsuite, 2020). Perera et al. (2022) have argued that social media marketing activities have a substantial impact on the credibility of higher education institutions' brands in Sri Lanka, concurrently reducing uncertainty and enhancing brand equity, particularly in Sri Lanka and Vietnam. Consequently, the formulation of branding and marketing strategies by higher education institutions through social media campaigns is imperative for effectively reaching their target audience.

The communication potential offered by social media is vast, transcending geographical boundaries and operating at lightning speed. When considering the audience, educational institutions must tailor their strategies to effectively engage with younger audiences, such as Generation Z, who exhibit distinct preferences and expectations for digital content. According to Anderson (2019), a significant limitation of higher education institutions lies in the lack of adequate funding, which can greatly impede their ability to connect with prospective students and launch successful marketing initiatives. Many educational institutions operate within constrained budgets for digital marketing efforts, making the effective allocation of resources a substantial challenge that directly impacts the quality of their marketing materials.

Furthermore, educational institutions deal with the responsibility of safeguarding sensitive student data, a significant concern when utilizing digital and social media platforms. Saleem and Siddik (2019) argue that technological and privacy concerns represent a crucial challenge within the realm of social media in the higher education sector. They emphasize the importance of sustaining follower engagement through attractive and timely content. For instance, this can involve sharing information about the institution's latest events, celebrating educational achievements, and highlighting alumni successes. Consequently, creating consistently high-quality, engaging content presents a challenge for many higher education institutions. The content is accurately curated to be as creative as possible to attract the audience, as underscored by Altamira et al. (2023). This creative content forms the institutional image as perceived by the audience.

Accordingly, educational institutions must ensure that their content effectively reaches prospective students, parents, and alumni. Furthermore, the pace of target audience engagement and feedback reception on social media is rapid, allowing for immediate

implementation of improvements, a cost-effective and efficient approach (Gondane and Pawar, 2021). Therefore, another challenge faced by higher education institutions lies in identifying and effectively reaching the appropriate target audience on social media. The audience remains consistently active, promptly responding to messages or posts across various social media platforms (Sędkowski, 2015). In instances where negative comments or reviews surface, they can rapidly gain viral traction on social media, posing a significant risk to an institution's reputation. This issue represents one of the biggest concerns faced by higher education institutions.

Furthermore, keeping abreast of the latest trends in social media and managing multiple platforms like Facebook, YouTube, WhatsApp, Twitter, Instagram, LinkedIn, TikTok, and more can become quite overwhelming. Private higher education institutions must treat these concerns seriously. According to Pucciarelli and Kaplan (2016), there have been discussions about three significant changes: enhancing prestige and market share, fostering an entrepreneurial mindset, and expanding engagements with stakeholders. Hence, the challenges associated with social media marketing in the private higher education sector hold considerable importance and cannot be disregarded. It is noticeable that there is a dearth of specific studies addressing social media marketing in the private higher education sector. Consequently, the findings are based on the literature's impact on both the Sri Lankan and global contexts. If all private higher education institutions respond promptly to these shifts, it will facilitate the development of their brand, enhance the admissions process for prospective applicants, and distinguish them from their competitors in the higher education arena.

## 4. Conclusion

In conclusion, private higher education institutions encounter significant challenges within the domain of social media marketing. Social media marketing has not only profoundly influenced higher education marketing but has also left a lasting impact on the entire higher education landscape. Across the globe, most academic institutions have integrated digital marketing technologies into not only their teaching and learning processes but also their efforts to connect with and engage their potential audience. These digital marketing campaigns yield consistent returns, transforming education into a globally accessible service within an increasingly complex and competitive knowledge marketplace. Currently, in most Asian countries, like Sri Lanka, the utilization of social media platforms lags behind that of more developed countries. Consequently, the use of social media in private higher education institutions in Sri Lanka presents numerous challenges. Consequently, the implementation of effective strategies and techniques for social media marketing has assumed greater importance than ever before, both in Sri Lanka and across the world. Nevertheless, it is crucial to acknowledge that, in the face of these challenges, opportunities for innovation and growth abound.

Therefore, this research focuses on determining the challenges associated with the effective implementation of social media marketing within the private higher education sector, both in the Sri Lankan and global contexts, relying on secondary data. Initially, a descriptive study was conducted utilizing secondary data gathered from a literature survey, analyzing seven research articles hailing from Asia, Europe, and North America that pertained to this topic. The challenges identified encompass privacy concerns, target audience, content quality, negative feedback, resource constraints, trends and platform diversity, maintaining brand quality, enhancing the prestige and market share, increasing an entrepreneurial mindset, and

expanding interactions with stakeholders. These challenges are generally applicable to the Sri Lankan context as well and are poised to be valuable for future research endeavors in Sri Lanka.

To overcome these challenges of social media marketing, following practical recommendations such as having a clear policy for handling sensitive information like student data and ensuring all social media posts meet legal standards, using analytical tools to gather insights and adapt strategies based on the data collected, monitoring key performance indicators (KPIs) such as enrollment rates, engagement rates, click-through rates, conversion rates, etc., to measure the effectiveness of the marketing campaigns, fostering a sense of community by actively engaging with the audience through comments, messages, and discussions, organizing live Q&A sessions, webinars, or virtual campus tours to involve prospects and provide valuable information to new users, continuously staying updated with social media trends and procedure changes to adjust the institute's strategy accordingly to navigate these challenges effectively.

By identifying these challenges, decision-makers and key stakeholders within both private and public higher education institutions can devise comprehensive strategies to effectively navigate and overcome these challenges. By giving priority to the challenges posed by social media marketing within the private higher education sector, decision-makers and policymakers can make informed decisions about where to direct their focus. Consequently, private higher education institutions must be proactive in embracing change, investing in continuous education and training, collaborating with marketing professionals, and validating pertinent guidelines and a well-structured roadmap. This approach will enable their respective institutions to adeptly navigate the challenges presented by the 21st century digital landscape in higher education.

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# IMPROVING SCHOOL-BASED MANAGEMENT IN SRI LANKA: PERCEPTION OF SCHOOL COMMUNITIES ON SCHOOL AUTONOMY

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## Abstract

Enhancing autonomy via the School-Based Management (SBM) initiative stands as a pivotal administrative reform to facilitate effective decision-making and community engagement within the education transformation process. This research endeavour aims to ascertain the perspectives of school communities regarding their current level of autonomy and the extent of autonomy they aspire to achieve in the future. The study employed a qualitative research methodology, incorporating both key informant interviews (KIIs) and focus-group discussions (FGDs). Four schools situated in a district in Sri Lanka were purposefully selected for inclusion in the study, with two being national schools and the other two being provincial schools. Data analysis was done using a qualitative approach. Most survey participants expressed a willingness to assume greater autonomy in financial management and educational quality development, with a supportive monitoring system in place from higher authorities and sufficient financial and human resources. However, it was observed that the realization of theoretical concepts and their implementation varied significantly due to factors such as the leadership qualities of principals, the attitudes and motivation of educational personnel and the school community, resource availability, existing rules and regulations, and the inherent structure of the school system. Policymakers must ensure that the delegation of school autonomy is approached comprehensively within the broader context of the education system, and administrative reforms should address the heterogeneity of the education system.

**Keywords:** School-based management, Autonomy

## Extended Abstract

### 1. Introduction

Presently, the Sri Lankan educational landscape exhibits a decentralized structure, wherein governance is distributed between the central government and nine provincial councils. According to the statistics of the Ministry of Education (MoE), there are 10,156 government schools in Sri Lanka (MoE, 2021). Among these, 396 are classified as national schools, and their administration is conducted under the direct purview of the MoE. Conversely, the remaining 9,756 schools fall within the jurisdiction of the nine provincial councils. Moreover, different SBM programmes have been introduced in Sri Lanka since the 1990s, and some programmes succeeded while others failed due to various reasons. The Enhanced Programme for School Improvement (EPSI) is being implemented in government schools in line with SBM principles with the objective of increasing the autonomy of schools through strong community involvement.

The SBM concept has been executed in various manners across diverse countries based on the reform objectives. "School autonomy is a form of school management in which schools are given decision-making authority over their operations, including the hiring and firing of personnel, the assessment of teachers, and pedagogical practices" (World Bank, 2007).

Out of the four models of SBM identified by Leithwood and Menzies (1998), the Sri Lankan education system uses the "Balanced Control method" to promote community participation in school decision-making processes. Following the balanced controlled model, it gives authority to a School Development Committee (SDC) which is comprised of both professionals (principals, teachers, and education officers) and the community (parents, community, and past pupils). The areas where autonomy is granted encompass: school-based planning, curriculum and co-curricular activity development, teacher development programmes at the school level, resource mobilization, and community participation enhancement.

Examining the perception of school communities regarding school autonomy holds particular significance, especially in light of ongoing reforms by the MoE in Sri Lanka's school education system. This study focused on the perceptions of school communities on school autonomy concerning school autonomy in the domains of financial management and education quality control.

## 2. Methodology

A qualitative research methodology was employed, using key informant interviews (KIIs) and focus group discussions (FGDs). Four schools within a designated district were selected for this study, comprising two national schools and two provincial schools. KIIs were conducted with all four principals, in addition to several administrative officers, parents, and former pupils who currently serve as members of the School Development Executive Committees (SDECs). FGDs were conducted with a group of teachers. Data analysis was conducted utilizing a qualitative approach.

The selected district represents a low socio-economic condition relative to other districts. Furthermore, this district falls within the 'difficult' category according to university selection criteria. The selection of four schools was based upon the categorization of their administrative bodies, encompassing national and provincial schools, while also encompassing a mix of both rural and urban institutions.

The selected schools are categorized as Category 1: National Schools (NS) and Category 2: Provincial Schools (PS).

## 3. Results and discussion

**Knowledge on SBM:** Overall, the majority of participants, with the exception of a few parents, demonstrate awareness of SBM, irrespective of their age and experience. Principals, teachers, school community members, education administrative officers, and some parents possess an understanding of the SBM concept and its objectives. While most SDC members have gained knowledge about SBM through guideline documents and circulars, none of the interviewed

parents have engaged with such circulars or guidelines, despite the Ministry of Education's issuing of clear guidance and instructions through these means.

**Current SBM practices in Sri Lankan education system:** The data analysis revealed disparities between the policy created at the central level and its actual execution at the grassroots level. Each school adopts its unique approach to implementing SBM, guided by their own knowledge and available resources, although the MoE furnishes rules and regulations for reference. All the interviewed education administrative officers share the view that SBM is a commendable policy in theory, yet the practical implementation on the ground does not align with this perception.

SDC assumes a crucial role in the decision-making process; therefore, the careful selection of SDC members is of paramount importance to ensure impartial decision-making. Further, it was visible that some principals still influence the decision-making process of SDCs. All respondents from the schools stated that there was no influence on the election of SDC members. In contrast, some education administrative officers stated that some school principals influenced the selection process both in popular urban schools and rural schools.

Both schools under category 2 are facing problems in selecting suitable persons from the parent and old pupil categories, as most of them are not professionally qualified. They do not have sufficient knowledge of decision-making for school quality improvement. In category 2 schools mostly use a professional control model rather than the balanced control model of SBM, although the school community prefers collaborative decision-making. Even it seems that in some category 1 schools, the administrative models are practiced depending on the power of the principal.

Although decisions on all development activities are made by the SDC, more priority was given to the implementation of physical facilities development projects, co-curricular and extra-curricular activities, student welfare programmes, and organization of the events. SDC members from the parents and community were not involved in the formal curriculum implementation process or teacher evaluation process.

**Community involvement:** One of the main objectives of SBM was to increase community participation in school development activities. Although community participation in school activities has increased with the introduction of the SBM into the school system, the level of participation depends on several factors, such as the leadership qualities of the principals, the motivation of the community, the benefit to the community, and social and economic factors. Low community participation can be seen in both schools under category 2 compared to the other two schools. A substantial portion of the school community in category 2 schools is uneducated and predominantly engages in labour-intensive roles within the nearby tea plantations. Consequently, they encounter limitations in their ability to contribute, either financially or in terms of school management, to the school's activities.

Despite the similarities in characteristics between the two Category 1 schools, one of them exhibits greater community participation than the other. It seems that the personality and public relations of the principal directly determine the motivation of the community for school activities.

**School autonomy on financial management:** Most schools are ready for greater financial autonomy with the support of higher authorities. According to the information provided by the

majority of respondents from the school, some changes need to be made to the school financing circular for efficient use of funds in school management. Three principals out of four recognized that more autonomy for the schools in financial management will increase the efficiency and productivity of the programmes, conversely, a principal from one national school perceived that increasing financial autonomy for the school is an additional burden for the school principals and teachers. Both the schools under category 2 principals liked to be more autonomous with a better supporting system from the higher authority. Both of them perceived that, if schools received funds directly to the school, school communities could allocate these funds according to their priorities. It leads to more effective utilization of government money.

In the case of one national school, all teachers, parents, and former pupils expressed a unanimous belief that increasing the school's financial autonomy is imperative to accelerate its programmes and activities. They also have confidence in their principal's ability to effectively manage financial matters and garner support from all school stakeholders without any issues. Conversely, the teachers at the other NS perceived that greater financial autonomy would pose a challenge for them.

According to the views of all education administrative officers, most of schools in the current education system do not perform financial management at a satisfactory level at the school level. According to their perception, the lack of knowledge of the school teachers, and principals, and the attitude of the principals are the main reasons for this issue. Also, some of them held the perception that the misappropriation of funds occurs intentionally in certain schools, while in others, it results from a lack of knowledge.

In contrast to other parties, administrative officers perceived that the existing autonomy is enough for the schools, as some of the leading schools misuse their autonomy while small schools do not have the capacity to manage financial resources at schools.

This information shows that school principals who have the knowledge and competencies would like to be more autonomous in financial management, and if school principals are visionary leaders, they have the ability to influence and motivate their subordinates and communities to be more autonomous without any fear. The attitude and motivation of the school community are another reason for the success of financial management at the school level.

The majority of respondents believe that resource generation poses a challenge for schools. However, a minority perceive that they can secure funds for school development activities through avenues such as past pupil associations, well-wishers, and renting out certain school assets. Analysis of the respondents from category two schools revealed that resource generation at the school level is challenging for these kinds of schools. Analysis of the responses from education administrators reveals that granting schools autonomy in resource mobilization, without concurrent monitoring authority vested in higher authorities, may not be advisable. This is primarily because many well-established schools tend to misuse their autonomy, while smaller schools lack the capacity for resource generation.

Based on the responses, several challenges impede financial management at schools. These challenges include financial constraints, difficulty in finding suppliers, a shortage of non-academic staff, teacher reluctance to assume key roles within the SDC such as treasurer,

limited knowledge of financial management, excessive workload for teachers, inadequate external auditing, conflicting guidance from circulars and education officers, insufficient oversight from higher authorities, a shortage of education administrative officers in zonal education offices, and delays in receiving financial resources from the MoE or Provincial Ministries of Education.

**School autonomy on education quality development:** With the introduction of the SBM, school autonomy on education quality development has been increased at the school level. By observation and analysis of the responses, it is revealed that all kinds of schools are utilizing their autonomy for improvement of the quality of education in different ways according to their capacity. However, all respondents, including education officers, perceived that schools currently have adequate authority to implement quality education programmes. Education officials argued that the government has to provide financial support for the small schools to mitigate the disparities among schools.

**School-Based Teacher Development (SBTD):** The systematic SBTD programme was implemented within the education system in 2012 under the SBM. However, this investigation revealed that the SBTD concept had not yet become fully integrated into the school system. External stakeholders, including parents and former students, seemed to lack awareness of this concept, and teachers were also unable to provide clear explanations.

## 4. Conclusions

Based on the research findings, it can be revealed that the extent of SBM implementation in schools is depending upon several factors. Within the Sri Lankan education system, there are schools that have effectively integrated SBM practices, whereas some have struggled to do so at the school level. Key determinants influencing SBM effectiveness include the leadership qualities of the principal, socioeconomic conditions within school communities, teacher qualifications and experience, as well as the availability of resources, unnecessary rules and regulations, and the school system itself.

However, in light of the findings from this study, it is evident that school communities willing to assume greater autonomy in financial and quality management, coupled with appropriate authority and robust support from higher-level authorities, are more likely to excel in SBM implementation.

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# IMPROVING SCHOOL-BASED MANAGEMENT IN SRI LANKA: PERCEPTION OF SCHOOL COMMUNITIES ON SCHOOL AUTONOMY

**N.C. Dasanayaka**[1]

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## Abstract

Enhancing autonomy via the School-Based Management (SBM) initiative stands as a pivotal administrative reform to facilitate effective decision-making and community engagement within the education transformation process. This research endeavour aims to ascertain the perspectives of school communities regarding their current level of autonomy and the extent of autonomy they aspire to achieve in the future. The study employed a qualitative research methodology, incorporating both key informant interviews (KIIs) and focus-group discussions (FGDs). Four schools situated in a district in Sri Lanka were purposefully selected for inclusion in the study, with two being national schools and the other two being provincial schools. Data analysis was done using a qualitative approach. Most survey participants expressed a willingness to assume greater autonomy in financial management and educational quality development, with a supportive monitoring system in place from higher authorities and sufficient financial and human resources. However, it was observed that the realization of theoretical concepts and their implementation varied significantly due to factors such as the leadership qualities of principals, the attitudes and motivation of educational personnel and the school community, resource availability, existing rules and regulations, and the inherent structure of the school system. Policymakers must ensure that the delegation of school autonomy is approached comprehensively within the broader context of the education system, and administrative reforms should address the heterogeneity of the education system.

**Keywords:** School-based management, Autonomy

## Extended Abstract

### 1. Introduction

Presently, the Sri Lankan educational landscape exhibits a decentralized structure, wherein governance is distributed between the central government and nine provincial councils. According to the statistics of the Ministry of Education (MoE), there are 10,156 government schools in Sri Lanka (MoE, 2021). Among these, 396 are classified as national schools, and their administration is conducted under the direct purview of the MoE. Conversely, the remaining 9,756 schools fall within the jurisdiction of the nine provincial councils. Moreover, different SBM programmes have been introduced in Sri Lanka since the 1990s, and some programmes succeeded while others failed due to various reasons. The Enhanced Programme for School Improvement (EPSI) is being implemented in government schools in line with SBM principles with the objective of increasing the autonomy of schools through strong community involvement.

The SBM concept has been executed in various manners across diverse countries based on the reform objectives. "School autonomy is a form of school management in which schools are given decision-making authority over their operations, including the hiring and firing of personnel, the assessment of teachers, and pedagogical practices" (World Bank, 2007).

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Examining the perception of school communities regarding school autonomy holds particular significance, especially in light of ongoing reforms by the MoE in Sri Lanka's school education system. This study focused on the perceptions of school communities on school autonomy concerning school autonomy in the domains of financial management and education quality control.

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A qualitative research methodology was employed, using key informant interviews (KIIs) and focus group discussions (FGDs). Four schools within a designated district were selected for this study, comprising two national schools and two provincial schools. KIIs were conducted with all four principals, in addition to several administrative officers, parents, and former pupils who currently serve as members of the School Development Executive Committees (SDECs). FGDs were conducted with a group of teachers. Data analysis was conducted utilizing a qualitative approach.

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# "THE IMPORTANCE OF LANGUAGE IN HIGHER EDUCATION OF SRI LANKA"

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**2023**

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## Abstract

Sri Lanka finds itself at a critical juncture in its journey, during the period 2023., towards equitable and inclusive higher education. This summary highlights the paramount importance of language in higher education in Sri Lanka, a country marked by rich linguistic and cultural diversity.

Sri Lanka boasts a multilingual population, with Sinhala, Tamil and English playing a central role. Language is not simply a communication tool; it is linked to identity, culture and social cohesion. This article explores the multifaceted importance of language in higher education, emphasizing the importance of addressing linguistic challenges and harnessing linguistic diversity for educational and social progress.

Challenges related to language policy and its implementation persist, posing significant obstacles to effective higher education. Ethnic and linguistic divisions have always been controversial in Sri Lanka, often leading to unequal access to resources and educational opportunities. The lack of standard language policies has contributed to disparities between institutions and students.

This article highlights the need for standardized national language policies to ensure equitable access and quality education in Sinhala and Tamil.

In addition, the article explores potential opportunities for improvement and development.

It emphasizes the importance of investing in bilingual teacher training, allocating resources for bilingual instructional materials, and cultural sensitivity training for educators to create inclusive learning environments.

Promoting multilingualism, especially fluency in Sinhala, Tamil and English, can enhance students' competitiveness in the global job market. As Sri Lanka continues its journey towards reconciliation and sustainable development, language in higher education plays a central role. The education system is not only a place to acquire knowledge but also a platform that promotes solidarity and respect among diverse linguistic communities.

This article argues for culturally sensitive language policies that are developed in collaboration with local communities and contribute to broader peacebuilding initiatives. In conclusion, this abstract highlights the enduring significance of language in higher education in Sri Lanka.

It serves as a foundation for future research and policy initiatives, emphasizing the need for linguistic inclusivity, standardized language policies, and the harnessing of linguistic diversity for the betterment of the nation in 2023 and beyond.

## 1, Introduction

### 1.1 Research Topic: The Importance of Language in Higher Education of Sri Lanka

The dynamics of education have always been significantly shaped by language, and this is especially true in the context of higher education. This study explores the many dimensions of language's significance in higher education, concentrating on Sri Lanka's varied linguistic environment. With English, Tamil, and Sinhala making up the majority of the country's linguistic fabric, the importance of language in higher education may be studied against a distinctive background.

### 1.2 Rationale for the Study

The language used in higher education settings has a significant impact on a number of factors, including academic success, inclusivity, accessibility, and participation in the global knowledge-sharing community. The linguistic diversity of Sri Lanka and the decisions made on language use in postsecondary educational institutions have a big influence on students' academic paths. The need to comprehend and assess the intricate interactions between languages in Sri Lanka's higher education system, with a focus on the effects of language selection on students and the larger academic community, is the driving force behind this project.

### 1,3 Research Questions and Objectives

This research paper seeks to address the following research questions:

1. What are the language policies and practices in Sri Lankan higher education institutions?
2. How do language choices in higher education impact access and inclusivity for students from diverse linguistic backgrounds?
3. What is the role of language proficiency in students' global competitiveness and academic mobility?
4. How do language policies affect research capabilities, academic publishing, and international collaboration in Sri Lankan higher education?

### 1,4 The objectives of this study are to:

- Examine the historical context and evolution of language policies in Sri Lankan higher education.
- Analyze the impact of language policies on access to higher education and inclusivity for students.
- Investigate the role of language proficiency in students' international mobility and employability.

- Assess the implications of language policies for academic research and knowledge dissemination in Sri Lanka.

### 1.5 Significance of the Research

This research holds significance on multiple levels. First, it contributes to the existing body of knowledge on language policies in higher education, with a specific focus on Sri Lanka. The findings of this study will be invaluable for policymakers, educators, and institutions in Sri Lanka who are concerned with enhancing access, inclusivity, and the quality of higher education. Second, the research sheds light on the global competitiveness of Sri Lankan graduates in the context of language proficiency, which is of paramount importance in an increasingly interconnected world. Finally, the study addresses issues of cultural diversity, identity, and linguistic inclusivity in education, which are crucial in a multicultural society like Sri Lanka.

### 1.6 Overview of the Paper's Structure

The format of this document is as follows: We will explore the past and present of language policies in Sri Lankan higher education in the sections that follow. We will look at how students' language choices affect diversity, accessibility, and their ability to compete globally. We will also look at how language functions in scholarly research and cross-border cooperation. A summary of the main conclusions and suggestions for improving language practices and policy in Sri Lankan higher education are included in the paper's conclusion.

We will go deeper into these topics in the upcoming parts, utilizing relevant literature, historical background, contemporary practices, and insights from case studies, interviews, and relevant literature.

## 2. Literature Review:

2.1 Overview of language policies in Sri Lankan higher education.

2.2 Historical context of language in education.

2.3 Comparative analysis of language use in higher education globally.

2.4 Review of previous research on the topic.

### 2.1 Literature Review

#### Overview of Language Policies in Sri Lankan Higher Education

Research and discussion on Sri Lanka's language policies in higher education have been extensive. Because English, Tamil, and Sinhala are the three most widely spoken languages in the nation, selecting a language for educational institutions has become extremely important. Many language policies have been put in place over time to address concerns about academic quality, diversity, and accessibility. The goal of these regulations has been to provide fair access

to higher education while taking into account the linguistic variety of the country. (Indika Liyanage, 2019)

In the past, the political and social climate of Sri Lanka has influenced language regulations in higher education. Education was significantly impacted by the Official Languages Act of 1956, which made Sinhala the only official language of the country. Due to this policy, there was a transitional period during which instruction and educational materials were provided in Sinhala. But the minority of Tamil speakers expressed worries about how inclusive and accessible education was for their group, which ultimately resulted in the "Bilingual Policy" being put into place in 1958, allowing both Sinhala and Tamil to be used in the classroom. (Wyss, 2020)

### 2.2 Historical Context of Language in Education

A number of policy changes reflecting the changing sociopolitical situation of the country have defined the historical background of language in Sri Lankan education. Identity, accessibility, and equality considerations have shaped language policy. For instance, the 1987 Indo-Lanka Accord significantly contributed to Tamil's designation as an official language, which had an additional impact on educational procedures. (Sri Lanka Secretariat for Coordinating the Peace Process (SCOPP), July)

Language policy underwent several modifications in the years following independence. Language choices in schooling were further influenced when Sri Lanka proclaimed Sinhala to be the official language of the country in 1972 (Wyss, 2020). subsequently implemented policies with the goal of encouraging the teaching of Tamil, especially in regions where the language is widely spoken.

### 2.3 Comparative Analysis of Language Use in Higher Education Globally

The wide range of language regulations and practices that are in place is highlighted by a comparative study of language use in higher education across the globe. Although many educational institutions across the world still use English as their primary language of instruction, countries like Sri Lanka face unique difficulties because of their multilingual environment. These comparative studies provide Sri Lanka with priceless lessons about the benefits and drawbacks of various language options for higher education.

**2.3.1**

1. **Diversity of Language Policies**:
    - Language policies in higher education vary significantly across the globe. Some countries adopt a monolingual approach, while others embrace bilingual or multilingual systems. The choice of language is often influenced by historical, cultural, and economic factors.

2. **Dominance of English**:
    - English remains a prevalent language of instruction in many international universities. This is primarily due to its status as a global lingua franca, which can

attract international students and foster access to global knowledge and opportunities.

3. **Challenges in Multilingual Contexts**:
    - Multilingual countries like Sri Lanka encounter unique challenges. They must balance the need to preserve cultural and linguistic identities while also preparing students for the global job market. Language choices are deeply entwined with social and political dynamics.

4. **Lessons from Comparative Studies**:
    - Comparative studies allow countries like Sri Lanka to learn from the experiences of others. They offer insights into the advantages and drawbacks of different language policies. For instance, some countries may have successfully leveraged bilingualism to promote inclusivity.

5. **Informed Decision-Making**:
    - The insights gained from comparative studies help policymakers and educational institutions make informed decisions about language policies in higher education. These decisions can shape access, inclusivity, and global competitiveness.

In summary, a global comparative analysis of language use in higher education reveals the rich tapestry of language policies and practices. While English continues to hold a strong position, countries with multilingual contexts face unique challenges. By studying the experiences of other nations, these countries can make more informed decisions about language policies, ensuring that they balance the preservation of cultural identities with global competitiveness in higher education.

**2.3.2 Language Policy in Higher Education Globally: Sri Lanka**:

- **Multilingual Society**: Sri Lanka contends with a diverse linguistic landscape, where Sinhala, Tamil, and English play significant roles.
- **Historical and Political Factors**: Language policies in Sri Lanka have deep historical roots, with Sinhala and Tamil serving as mediums of instruction, while English's legacy stems from colonial rule.
- **Policy Documents**: The Sri Lankan government has introduced initiatives to promote Tamil in higher education, exemplified by the establishment of Tamil language departments and bilingual programs.

**India**:

- **Linguistic Diversity**: India's rich tapestry of languages results in a plethora of languages used in higher education.
- **Historical Factors**: The influence of colonialism has bestowed prominence upon English, though Hindi and regional languages also feature prominently.
- **Policy Documents**: The National Education Policy 2020 advocates multilingualism, with a particular emphasis on utilizing regional languages in education.

**China**:

- **Mandarin Dominance**: China's educational landscape is predominantly characterized by the use of Mandarin as the primary medium of instruction.
- **Historical and Political Factors**: The standardization of Mandarin was a politically motivated endeavor to foster national unity.
- **Government Directives**: The Ministry of Education actively encourages universities to offer English-taught programs, aiming to attract international students.

**United States**:

- **English Dominance**: English takes the central stage in U.S. higher education as the primary language for both instruction and administration.
- **Historical and Cultural Context**: The historical and cultural legacy of English deeply influences its preeminence.
- **International Students**: The presence of a substantial international student body contributes to linguistic diversity in U.S. universities.

**2.3.3Language Use in Universities Worldwide**:

**Sri Lanka**:

- **Multilingual Lectures**: Sri Lankan universities employ Sinhala, Tamil, and English for lectures. Bilingual policies are particularly observed in regions with Tamil-speaking populations.

**India**:

- **Multilingual Lectures**: Lectures are delivered in various languages, encompassing English and regional languages. English significantly prevails in postgraduate and technical education.
- **Research in English**: English dominates as the language for research papers.

**China**:

- **Mandarin Instruction**: While Mandarin primarily serves as the medium of instruction in Chinese universities, the prevalence of English-taught programs is on the rise.
- **Research in English**: Chinese researchers frequently publish their work in English to reach a global audience.

**United States**:

- **English Lectures and Textbooks**: English takes the lead as the primary language employed in lectures, textbooks, and research across U.S. universities.

**2.3.4 Challenges and Benefits of Multilingual Education**:

**Sri Lanka**:

- **Benefits**: Multilingual education serves as a preserver of cultural diversity.
- **Challenges**: The balancing act between multiple languages, ensuring language proficiency, and facilitating equitable access presents ongoing challenges.

**India**:

- **Benefits**: Multilingualism safeguards cultural diversity and enhances accessibility.
- **Challenges**: Striking a balance between multilingualism and global competitiveness remains a formidable challenge.

**China**:

- **Benefits**: Mandarin acts as a unifying force among a diverse populace, while English programs attract international students.
- **Challenges**: Upholding the quality of English-taught programs and ensuring proficiency among students and faculty poses significant challenges.

**United States**:

- **Benefits**: English, as a global lingua franca, attracts a diverse international student body.
- **Challenges**: Furnishing adequate support for non-native English speakers is pivotal to ensure their academic success.

**Documentary Proof**:

- In Sri Lanka, the initiatives of the Sri Lankan government to promote the use of Tamil in higher education are substantiated by official government reports.
- In India, the language-related strategies outlined in the National Education Policy 2020 serve as documentary evidence. (Ministry of Education)
- In China, the directives issued by the Ministry of Education, guiding universities to offer English-taught programs, provide documentary proof. (Ministry of Education of People's Republic of China)
- In the United States, comprehensive documentation on the language of instruction and the presence of international students is readily accessible through university websites and official documents. (Knutson)

In summary, language policies in higher education are deeply rooted in historical, political, and cultural contexts. These policies mold the landscape of accessibility, inclusivity, and global competitiveness in higher education. The region-specific challenges and advantages of multilingual education offer invaluable insights into the global panorama of language use in universities.

## 3. Language Policies in Sri Lankan Higher Education:

- Discussion of the language of instruction in Sri Lankan universities.
- Examination of language diversity and the role of Sinhala, Tamil, and English.
- Analysis of policies related to language use, including medium of instruction and language requirements.

### 3.1 Language of Instruction in Sri Lankan Universities:

The language of instruction in Sri Lankan colleges has always been a complicated matter impacted by sociocultural, political, and historical variables. The official languages of Sri Lanka and Tamil are both acknowledged, with English holding a prominent position. There have been changes in the language of instruction in universities throughout Sri Lanka's history. For example, English predominated throughout the colonial era, but as a way to foster national identity, there was a move towards Sinhala following independence. (FACTS AND DETAILS, 2018-2019) English has seen a renaissance in recent years, fueled by the realization of its significance in the global labor market and the aim to draw in foreign students.

Universities in Sri Lanka have experienced substantial changes in the language of instruction, which is still a complicated matter impacted by a number of historical, political, and sociocultural variables. This is a summary of its development:

### 3.1.2 Colonial Era-English Domination:

Because of British colonial authority, English was the most widely used language of instruction at Sri Lankan colleges throughout this time. English served as the official language of government and administration in addition to education. (Wong, 2020)

### 3.1.3 Post-Independence Shift to Sinhala:

The promotion of national identity led to a substantial change in language policy in Sri Lanka following the country's 1948 independence. In an effort to emphasize the cultural and linguistic legacy of the majority of Sinhala speakers, there has been a shift in colleges toward adopting Sinhala as the main language of instruction. (Wong, 2020)

"The Official Language Act (No. 33 of 1956), commonly known as the Sinhala Only Act, was passed in the Parliament of Ceylon in 1956. This legislation replaced English with Sinhala as the exclusive official language of Ceylon, excluding Tamil. (Wikipedia, 2023)

At the time, Sinhala, also referred to as Sinhalese, was the language of the majority Sinhalese population, constituting approximately 70% of the country's total population. On the other hand, Tamil was the primary language of Ceylon's three largest minority ethnic groups, namely the Indian Tamils, Sri Lankan Tamils, and Moors, who collectively represented around 29% of the country's population."

### 3.1.4 The Tamil language plays a significant role in Sri Lankan society.

It is an official language of the country, and measures have been implemented to provide higher education to Tamil-speaking groups.

Policies and initiatives in both languages have arisen, particularly in places where there is a sizable Tamil-speaking populace.

According to Wikipedia, in 1958, the Tamil Language (Special Provisions) Act was enacted, granting official status to Tamil as the medium of instruction in school and university education, for admission to the public service, and for use in correspondence and administration in the Northern and Eastern Provinces. (Wikipedia, 2023)

"In 1958, certain provisions of the act were amended following a compromise known as the 'Sinhala Only, Tamil Also' agreement made by Tamil leaders. On September 3, 1958, the Tamil Language (Special Provisions) Act was enacted, facilitating the use of the Tamil language as a medium of instruction, for examination purposes for admission to the Public Service, in state correspondence, and for administrative functions in the Northern and Eastern provinces." (Wikipedia, 2023)

**3.1.5 English has been having a rebound in Sri Lankan universities in recent years, which has been fueled by a number of factors:**

The acceptance of English as a universal language and its significance for employment and communication across borders. (Sittarage, 2018)

The aim is establishing international partnerships and draw in foreign students.

The understanding that graduates' employability can be improved by knowing English, especially in fields like corporate outsourcing and information technology.

**3.2 Current Language Landscape:**

Depending on the university, program, and faculty, a combination of Sinhala, Tamil, and English are used in instruction in Sri Lankan universities nowadays. There are bilingual regulations in place in places where there is a sizable Tamil-speaking population, and several colleges offer courses in both Sinhala and English.

The intricate linguistic environment found in Sri Lankan colleges is a reflection of the nation's rich linguistic and cultural past. It also highlights the conflict between preserving and advancing the national tongues—Tamil and Sinhala—and ensuring that pupils are fluent in English in order to prepare them for a globalized future. Higher education institutions' dynamic language interactions are a reflection of how Sri Lanka's language regulations are still changing.

Sri Lanka's language regulations in higher education are still developing, which is in line with the government's resolve to address inclusion issues and the country's diverse linguistic environment. The nation aims to preserve its linguistic and cultural identity while simultaneously preparing students for possibilities and challenges found on a global scale.

In conclusion, the cohabitation of Sinhala, Tamil, and English in Sri Lankan institutions is typified by attempts to strike a balance between linguistic diversity, accessibility, and global competitiveness. The interaction of different languages demonstrates the nation's dedication to addressing the changing needs while also reflecting its rich cultural and linguistic legacy.

**3.2.1 Language Diversity and the Role of Sinhala, Tamil, and English:**

**Sinhala:**

**Predominant Language:** Sinhala serves as the primary language in Sri Lanka, primarily spoken by the Sinhalese ethnic group, which makes up the majority of the population.

**Educational Medium:** Traditionally, Sinhala has been the primary language used for teaching in numerous universities. This choice aligns with the dominant cultural and demographic role of the Sinhalese community within the nation.

**Cultural and Historical Value:** Sinhala carries substantial cultural and historical significance for the Sinhalese population, representing a cornerstone of their identity.

**Tamil:**

**Tamil-Speaking Communities:** The Tamil language is the primary linguistic choice among Tamil ethnic groups in Sri Lanka, especially in the Northern and Eastern provinces.

**Promotion of Bilingualism:** Advocates from Tamil-speaking communities have long pushed for the recognition of the Tamil language in higher education. Consequently, some universities and educational institutions have implemented policies that support bilingual education, offering courses and educational materials in both Sinhala and Tamil.

**Cultural and Historical Reverence:** The Tamil language holds a central place in the cultural and historical identity of the Tamil community, making its preservation and promotion vital for their well-being.

**English:**

**Global Significance:** English is widely utilized in Sri Lanka, particularly in higher education, due to its global relevance. It is often considered a gateway to accessing international knowledge and opportunities.

**Language of Education:** English is the primary medium of instruction in specific specialized programs and courses. This is particularly prevalent in fields such as science, technology, engineering, and mathematics (STEM), as well as in postgraduate and professional education. Economic and Career Prospects: Proficiency in English can significantly enhance employment prospects and provide access to global job markets, rendering it a valuable skill for students in Sri Lanka.

The linguistic diversity in Sri Lanka is a reflection of its multi-ethnic nature. The coexistence of Sinhala, Tamil, and English in the realm of higher education mirrors the intricate social, cultural, and historical dynamics within the country. While Sinhala and Tamil are pivotal for preserving the cultural identities of their respective communities, English plays a critical role in granting access to global knowledge and opportunities. Striking a balance among these languages in higher education is a delicate matter that necessitates thoughtful consideration of the requirements and aspirations of all ethnic groups in the nation.

### 3.3 Analysis of policies related to language use, including medium of instruction and language requirements of Higher Education in Sri Lanka.

The policies related to language use, including the medium of instruction and language requirements in Sri Lankan higher education, are the result of a complex interplay of factors, including historical, cultural, and economic considerations. Here is an analysis of these policies:

**3.1 Medium of Instruction:**

Sri Lanka has a historical pattern of alternating between Sinhala and English as the language of instruction in higher education. This shift has been shaped by various policies and legislative acts,

exemplified by the University of Ceylon Act No. 1 of 1942, which underscored the primacy of English as the medium of instruction in universities. (Indika Liyanage, 2019)

**3.2 Analysis:**

The oscillation between Sinhala and English mirrors the intricate historical and socio-political dynamics within the country. It underscores the struggle between preserving cultural identity through native languages and the imperative of English proficiency for international competitiveness.

**3.3 Bilingual Policies:**

In regions with notable Tamil-speaking populations, educational institutions have adopted bilingual policies in alignment with the Sri Lankan government's commitment to acknowledging the nation's linguistic diversity.

**3.4 Analysis:**

Bilingual policies represent a constructive stride toward inclusivity and accessibility, recognizing the significance of accommodating linguistic diversity within the education system.

**3.5 Language Requirements:**

Language prerequisites in higher education can differ based on the program and the institution. For instance, international programs may mandate that students demonstrate English proficiency through standardized assessments like IELTS or TOEFL.

**3.6 Analysis:**

These prerequisites align with the acknowledgment of the crucial role of English proficiency for global readiness, especially in disciplines where English serves as the principal language for research and communication.

**3.7 Education Policies and Acts:**

The Education Act of 1997, along with subsequent amendments, exerts substantial influence on the formulation of language policies in Sri Lankan education. These legislative frameworks delineate the legal underpinnings of the educational system in the country. (Sri Lanka's Universal Education System, 2019)

**3..8 Analysis:**

These legislative acts provide the foundational support for educational policies, including those concerning language, and may evolve over time to adapt to changing educational needs.

**3.9 Government Initiatives:**

The Sri Lankan government has initiated efforts to encourage the utilization of the Tamil language in higher education. These efforts include the establishment of Tamil language departments and the introduction of bilingual programs.

**3.10 Analysis:**

These initiatives signify the government's dedication to acknowledging and promoting linguistic diversity and cultural inclusivity.

In conclusion, language use policies in Sri Lankan higher education are intricate and have undergone evolution to address historical, cultural, and economic considerations. The analysis of these policies underscores the intricate balance between safeguarding cultural identity and preparing students for success in the global arena. To obtain the latest information regarding policies and legislative acts, it is crucial to refer to updated sources and official government documents.

### 3.11 Access and Inclusivity:

Access to and inclusivity in higher education in Sri Lanka are significantly influenced by language policies. Here is a concise summary with references to pertinent documents within the Sri Lankan context:

**Impact on Access to Higher Education**:

In Sri Lanka, language policies have a significant impact on how accessible higher education is. The traditional focus on English and Sinhala as the two main languages of instruction has caused difficulties, especially for pupils from other linguistic backgrounds, especially Tamil-speaking students.

**Documentary Evidence**:

- The University Grants Commission (UGC), which oversees higher education in Sri Lanka, plays a key role in formulating rules and regulations. These records, which include those that dictate which language is used as a teaching medium, demonstrate the historical importance of both English and Sinhala.
- Language rules have a negative impact on higher education access, especially for Tamil-speaking students, as evidenced by several reports and scholarly research (e.g., International Crisis Group). These academic publications provide concrete proof of the difficulties encountered by students from a variety of linguistic origins.

**3.2 Role of Language in Ensuring Inclusivity and Equity**:

When it comes to promoting fairness and diversity in the field of higher education, language is crucial. As a result, steps have been taken to establish multilingual policies and Tamil language departments in order to promote inclusivity and address the linguistic diversity that exists in the country.

**Documentary Evidence**:

- The Sri Lankan government has taken the initiative to create policies that promote diversity, including multilingual programs and the creation of Tamil language departments. These actions are formally recorded in official government statements and reports.
- The Education Act of 1997 and other relevant legislative instruments, along with other relevant statutes and amendments, offer the necessary legal frameworks for promoting equity and diversity in higher education through language-centric policies. (Sri Lanka's Universal Education System, 2019)

In summation, language policies in Sri Lanka exert a substantial impact on the accessibility of higher education, particularly for students emanating from a spectrum of linguistic backgrounds. The nation has embarked on initiatives to grapple with these challenges, promote inclusivity, and ensure equity, as evidenced by the introduction of bilingual policies and the establishment of departments catering to the linguistic diversity present in the country. These initiatives are enshrined in official government documents and reports, reflecting an unwavering commitment to bestow equal access to higher education upon all students, irrespective of their linguistic origins.

## 4.Language and Research:

Language proficiency, particularly in English, plays a pivotal role in shaping the global competitiveness of students in Sri Lanka. In this diverse and multilingual nation, English proficiency is a significant asset with far-reaching implications.

### 4.1 English Language Proficiency:

English holds a unique position as a global lingua franca, serving as a bridge across cultures, continents, and professions. Sri Lankan students who demonstrate proficiency in English gain a considerable advantage. They can access a wealth of international knowledge and resources that are primarily available in English. This proficiency is not just about fluency; it's about unlocking doors to international academic and professional networks.

Furthermore, effective communication is vital on the global stage, where English often acts as the common medium. Proficiency allows Sri Lankan students to actively engage in international forums, conferences, and collaborations. This competence is especially crucial in an era of global interconnectedness, where cross-border cooperation and knowledge exchange are the norm.

English proficiency also has a significant impact on employability. As Sri Lanka continues to engage with the global community, the ability to communicate effectively in English becomes a highly sought-after skill. Many multinational corporations, NGOs, and international agencies use English as their primary language for communication. Consequently, proficiency in English provides access to international job markets and business opportunities. It is not just a skill but also a key to unlocking global career prospects.

**4,2 Impact on Students' International Mobility:**

English proficiency greatly enhances the international mobility of Sri Lankan students. It opens doors to study abroad opportunities in English-speaking countries. This not only exposes students to diverse academic environments but also broadens their cultural horizons. Many international scholarships and exchange programs require a certain level of English proficiency. Students who are proficient have access to a wider range of financial aid and educational opportunities abroad. Moreover, the ability to communicate effectively in English equips students with cross-cultural competence, enabling them to adapt and excel in foreign academic and professional settings.

**4.3 Impact on Employability:**

In the global job market, English proficiency is often a prerequisite for employment in international companies and organizations. It significantly enhances employability in positions that require global interactions. It is particularly relevant for those seeking careers in research and innovation, as English is the dominant language in academic research and publications. As the job market becomes increasingly competitive, English proficiency sets students apart and reflects their capacity to work across borders and contribute effectively to international projects and collaborations.

**Documentary Proof:**

The significance of English language proficiency is evident in official documents, international scholarship requirements, and job advertisements. For instance, international scholarship programs often specify English language requirements. Job postings in Sri Lanka for international organizations and corporations regularly list English proficiency as a key qualification.

In conclusion, English language proficiency is a driving force behind the global competitiveness of Sri Lankan students. It enables access to international education, cross-cultural experiences, and a broader spectrum of employment prospects. In an increasingly interconnected world, proficiency in English is an invaluable skill that allows students in Sri Lanka to not only compete but thrive on the global stage.

## 5.Bilingual Education:

### 5.1 Examination of the challenges and benefits of bilingual education in Sri Lanka's higher education system:

Sri Lanka's higher education system has historically faced challenges and benefits related to bilingual education, primarily due to its multi-ethnic and multilingual composition.

Some key challenges and benefits can be highlighted:

5.1.1 Language Barrier:

Sri Lanka's population speaks several languages, with Sinhala and Tamil being the major languages. (Wijesekera, 2019)

Implementing bilingual education can be challenging due to the language barrier between students and faculty members.

5.1.2 Resource Allocation:

Resource allocation to bilingual programs, including hiring bilingual teachers and producing bilingual learning materials, can strain the education system's limited resources power. (Wijesekera, 2019)

5.1.3 Sociopolitical issues:

Language has been a source of tension in Sri Lanka's history.

The country's civil war was partly the result of linguistic and ethnic divisions, which can affect how bilingual education is viewed.

5.1.4 Maintaining quality:

Ensuring quality education in both languages can be challenging because some programs may prioritize one language over the other.

### 5.2 The role of bilingual programs in preserving linguistic diversity: Bilingual programs play an important role in preserving linguistic diversity worldwide.

5.2.1 Preserving endangered languages:

Bilingual programs can help protect and restore endangered languages by promoting their use in education. When a language is used in the school curriculum, it has prestige and is more likely to be passed on to the next generation.

5.2.2 Cultural preservation: Languages are closely linked to culture.

Bilingual education allows for the transmission of knowledge, traditions and cultural values, thereby ensuring the preservation of the community's cultural heritage.

Enhanced cognitive benefits: Bilingualism is linked to cognitive benefits, such as improved problem-solving skills and creativity.

Bilingual programs can help individuals develop fluency in multiple languages, contributing to cognitive diversity.

5.2.3 Connected Communities:

Bilingualism promotes connections between language communities.

People who speak multiple languages can more easily communicate and understand the perspectives of others, thereby promoting social cohesion.

5.2.4 Economic opportunities:

In a globalized world, knowing multiple languages can open up economic opportunities.

Bilingualism can facilitate international trade, travel and business interactions.

## 06. Challenges and Opportunities:

Language policy in Sri Lankan higher education has faced a number of challenges, mainly due to the country's multilingual and multi-ethnic composition. Identifying these challenges and discussing opportunities for improvement and growth is critical to creating a more inclusive and effective education system .Here are some key challenges and opportunities:

a. Ethnic and linguistic divide:

Sri Lanka's diverse population speaks different languages, with Sinhala and Tamil is the main language. This linguistic diversity can lead to ethnic and linguistic divisions, thereby complicating language policies.

b. Lack of standardization:

The lack of standardized language policies can create confusion and inequality in higher education. Some organizations may favor one language over another, leading to disparities.

c. Resource allocation:

The allocation of resources to bilingual education, including hiring bilingual teachers and producing learning materials, constitutes a significant challenge to the existing education system may have limited resources.

d. Political sensitivity:

Language issues have historically been sensitive in Sri Lanka, with language policies playing a role in ethnic and political tensions. This makes any changes to language policy political.

6.1 **Opportunities for Improvement and Development:**

a. Standardized Language Policies:

Developing and implementing standardized language policies at the national level can help ensure consistency and equal access to education in both Sinhala and Tamil.

b. Bilingual Teacher Training: Invest in training programs for bilingual teachers who can teach in both Sinhala and Tamil, ensuring a high level of proficiency in both languages.

c. Resource Investment: Allocate adequate resources to support bilingual education, including the development of textbooks and learning materials in both languages.

d. Cultural Sensitivity Training: Provide cultural sensitivity training for educators to create an inclusive and respectful learning environment for students from various linguistic and ethnic backgrounds.

e. Promote Multilingualism: Encourage students to be proficient in both official languages (Sinhala and Tamil) as well as English, promoting multilingualism and enhancing their competitiveness in the global job market.

f. Research and evaluation: Invest in research and evaluation of language policies and their impact on educational outcomes, enabling evidence-based decision making.

g. Community engagement: Involve local communities and language groups in the development and implementation of language policies to ensure that they are appropriate and sensitive culturally.

h. Peacebuilding Initiative: Links language policy to broader peacebuilding efforts, emphasizing the role of education in reconciliation and social cohesion.

## 7.Conclusion:

**Summary of Key Findings:**

This study has underscored the profound importance of language in the higher education system of Sri Lanka in 2023. Sri Lanka's linguistic and cultural diversity, characterized by Sinhala, Tamil, and English, has deep-rooted implications for the nation's educational landscape. The key findings of this research can be summarized as follows:

1. **Language as Identity:** Language in Sri Lanka is not just a means of communication; it is intertwined with identity, culture, and societal cohesion. The preservation and promotion of multiple languages are vital for the maintenance of diverse cultural heritages.
2. **Challenges in Language Policies:** The nation faces considerable challenges due to the absence of standardized language policies in higher education. These challenges include ethnic and linguistic divides, resource allocation disparities, and historical political sensitivities, resulting in unequal access to quality education.
3. **Opportunities for Improvement:** The study has highlighted several opportunities for the development and enhancement of language policies in higher education. These opportunities include investing in bilingual teacher training, allocating resources for bilingual education materials, and promoting cultural sensitivity among educators. Additionally, promoting multilingualism, particularly proficiency in Sinhala, Tamil, and English, can empower students for the global job market.

### 7.1 Implications for Sri Lankan Higher Education:

The research's implications for Sri Lankan higher education in 2023 are profound. It calls for a fundamental shift in how language is perceived and utilized within the educational system. Recognizing the significance of language, not only as a tool for instruction but as a bridge between communities, can pave the way for a more inclusive and harmonious educational environment. The implications extend to the preservation of cultural heritages, fostering unity, and promoting social cohesion in a society marked by diversity.

### 7.2 Recommendations for Policymakers, Universities, and Stakeholders:

Based on the findings and implications, the following recommendations are proposed for policymakers, universities, and stakeholders in Sri Lankan higher education:

1. **Standardized Language Policies:** Policymakers should prioritize the development and implementation of standardized language policies at the national level, ensuring consistent and equitable access to education in both Sinhala and Tamil. These policies should be inclusive, culturally sensitive, and relevant to all linguistic communities.
2. **Invest in Teacher Training:** Universities and educational institutions should invest in bilingual teacher training programs to ensure educators are proficient in both languages. This will play a crucial role in delivering quality education in an inclusive manner.
3. **Resource Allocation:** Adequate resources should be allocated to support bilingual education, including the creation of textbooks and learning materials in both languages, thereby ensuring equitable access to educational resources.
4. **Cultural Sensitivity:** Promote cultural sensitivity among educators, students, and stakeholders to create an inclusive and respectful learning environment that appreciates and celebrates linguistic diversity.
5. **Multilingual Competence:** Encourage students to achieve proficiency in all three official languages (Sinhala, Tamil, and English) to enhance their competitiveness in the global job market and promote societal unity.
6. **Community Involvement:** Involve local communities and linguistic groups in the development and implementation of language policies to ensure that policies respect and reflect their cultural values and needs.
7. **Peacebuilding Initiatives:** Link language policies with broader peacebuilding efforts, emphasizing the role of education in reconciliation and social cohesion.

In conclusion, this research underscores the pivotal role of language in higher education in Sri Lanka in 2023. It offers a roadmap for enhancing educational inclusivity, preserving cultural heritage, and fostering unity among a diverse population. Policymakers, universities, and stakeholders must act upon these recommendations to build a more equitable and harmonious educational system for the nation's future.

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## 8th INTERNATIONAL CONFERENCE ON MULTIDISCIPLINARY RESEARCH 2023

Session 07

**Multidisciplinary**

# EMPLOYABILITY SURVEY, 2022
# BRITISH COLLEGE OF APPLIED STUDIES, SRI LANKA

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## Abstract

The employability survey acts as a valuable benchmarking tool, offering crucial insights for the continuous improvement of higher education offerings. This comprehensive study has five primary objectives, with the main goal being the assessment of graduates' employability levels. To achieve this, a meticulously structured questionnaire was distributed to 2,000 students who had successfully completed their programs at the time of data collection. The subsequent analysis involved 447 completed responses, employing primarily descriptive statistics with SPSS Version 2.1. The research findings reveal that the employability rate at BCAS Campus stands at an impressive 70%, contributing to an overall employability rate of 67%. Notably, these rates exhibit variations across different schools, with computing/IT at 74%, management at a remarkable 86%, building studies at 60%, legal studies at 47%, and health science achieving an outstanding 99%. It is noteworthy that employed respondents express a high level of job satisfaction, and their contentment regarding the learning experience at BCAS and the value addition of their study program for personal growth is commendably elevated. However, the survey brings to light certain areas that warrant attention for further improvement. Specific aspects that may impact students' learning experiences have been identified, with the quality of facilities and infrastructure emerging as a paramount concern. In response to this, the management has taken proactive steps by initiating plans to relocate the main campus to a more conducive location and investing in technological and facility improvements—an encouraging and positive development. Another area identified for enhancement is the quality of delivery. The management could strategically focus on augmenting value-added services, increasing the institution's popularity and brand visibility, and strengthening communication among stakeholders. These measures are envisioned to collectively contribute to the amelioration of overall educational experiences and further elevate BCAS Campus as a hub for academic and professional excellence.

## Extended Abstract

### 1. Introduction

The exploration of employability has been a pervasive theme in academic literature, particularly within the realms of higher education and workplace learning (Römgens et al., 2020). Yorke (2006, p. 8), as cited in Römgens et al. (2020), defines individuals' employability as a culmination of achievements—comprising skills, understandings, and personal attributes—that enhance graduates' likelihood of securing employment and thriving in their chosen professions. This not only benefits the individuals themselves but also contributes to the workforce, the community, and the economy at large. Despite the expectation for every graduate to find employment in their chosen field, global unemployment remains a pervasive issue. Research indicates a substantial gap between the output of higher education institutes and the expectations of employers. Consequently, the employability of graduates has become a paramount concern for higher education institutions globally (Abelha et al., 2020; Mezhoudi et al., 2021; Ariyawansa, 2008; Römgens et al., 2020). Employability surveys play

a pivotal role in benchmarking and providing insights for the ongoing development of education policies and value propositions offered by higher education institutes. A notable instance is the employability survey conducted by the University Grants Commission of Sri Lanka, involving 1,265 graduates who completed their studies in 2015 and 2014 in 2018. This survey covered 14 public universities and two private higher education institutions (selected disciplines only) in Sri Lanka (Gunaratne et al., 2018). Overall, the survey found employability to be at 65%, with a higher percentage of graduates absorbed into government jobs. Additionally, it revealed that 1 in every 10 employed graduates is underemployed, engaged in jobs that do not require or utilize their education, such as clerical or allied roles. Noteworthy distinctions in employability levels were observed across disciplines, with architecture, computer science/IT, health science, and engineering graduates exhibiting higher levels, while graduates from the arts and performing arts faced challenges in securing employment. Ariyawansa's study (2008) further affirms that there are ample job opportunities for engineering, science, and management graduates, while humanities and social sciences graduates encounter fewer prospects.

However, there is a conspicuous gap in employability surveys covering private higher education institutes in the Sri Lankan context. Against this backdrop, this study focuses on one of the leading private higher education institutes in Sri Lanka, BCAS, which has stood the test of time for over two decades. With a student population exceeding 3500, BCAS comprises five schools—Business Management, Building Studies (Eng), Computer Science/IT, Law, and Health Science. The institute offers programs at four levels: foundation, HND, degree, and master's, in collaboration with British universities and institutions. The primary purpose of this survey is to analyze the employability status of graduates who have completed their studies at the British College of Applied Studies (BCAS) and to achieve the following specific objectives:

a. To ascertain the level of employability at each academic level and overall.
b. To gauge the level of job satisfaction among employed respondents.
c. To assess the level of satisfaction among respondents regarding their learning experience at BCAS.
d. To evaluate the level of satisfaction with the value addition of the BCAS study program.
e. To determine areas for improvement that will enhance students' experience at BCAS in the future.

## 2. Methodology

The survey is structured into two sections, with the first focusing on respondent demography and profiles, while the second collects data to fulfil predetermined objectives. Employing a 5-point Likert scale, ranging from 'strongly agree' to 'strongly disagree,' data analysis utilised SPSS software Version 2.1. Additionally, an open-ended question was included to extract insights for potential enhancements. Distributed to a database of 2000 respondents across all five schools and four academic levels, the questionnaire aimed to gather information on graduate employability, extending its focus to insights from other academic levels. Conducted in October 2022, the survey targeted individuals who had completed at least one programme by that time. The study received 449 completed responses, constituting 20% of the student pool. Respondents were distributed across schools as follows: 26% from the School of Computing, 25% from the School of Building Studies, 20% from the School of Management, 15% from Legal Studies, and 14% from the School of Health Science. Degree programmes were pursued by 43%, HND completion by 29%, the Access/Foundation programme by 13%, and postgraduate studies by 13%. Respondents' average age was 27 years, with an age range from 18 to 64 years. Age distribution included 52% below 25, 31% in the 26 to 32 range, 12% in the 33 to 40 bracket, 4% between 41 and 50, and 1% aged 51 and above. The sample comprised 71% males and 29% females, with 33% married and 67%

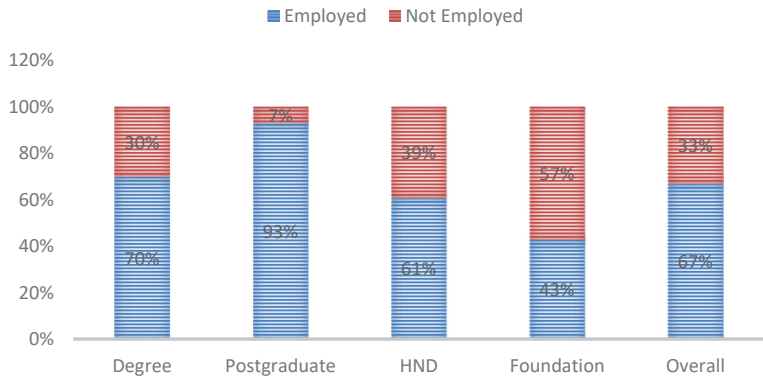
unmarried. Regarding the year of programme completion, the majority (50%) finished in 2021 and 2022, 27% between 2019 and 2020, and only 9% concluded in 2018 or earlier. Overall, the sample composition is deemed reflective of the broader population.

## 3. Results and Discussion

### Employability Status

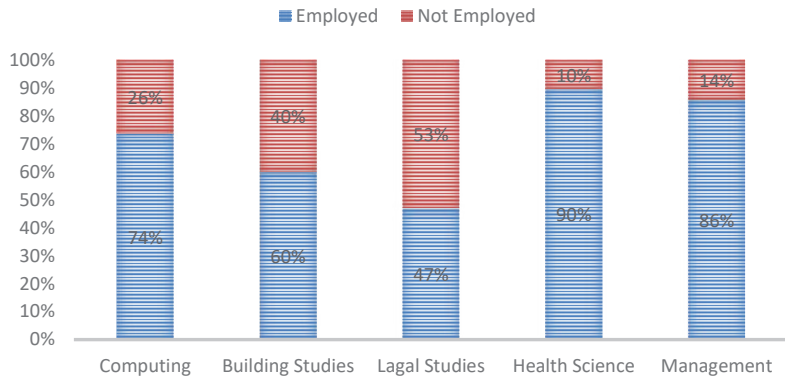
The overall employability of the surveyed individuals is 67%. When examining employability across programme levels, the postgraduate level exhibits a high employability rate of 93%, which is expected given the maturity of these individuals who pursue higher studies while working. The primary focus of the employability survey is on the employability of graduates. Across all degree programmes, the graduate employability rate is an impressive 70%, indicating excellent performance. Employability among HNDs is 61%, while at the foundation level, it stands at 43%. Foundation and HND programmes serve as entry qualifications for higher studies, with their primary goal being progression to the degree level rather than immediate employment. Typically, students at these levels are employed as trainees or interns. It is noteworthy that a higher percentage of both HND and foundation students engage in some form of employment or training in a real work context.

Figure 3.1: Employability Across Levels of Programmes



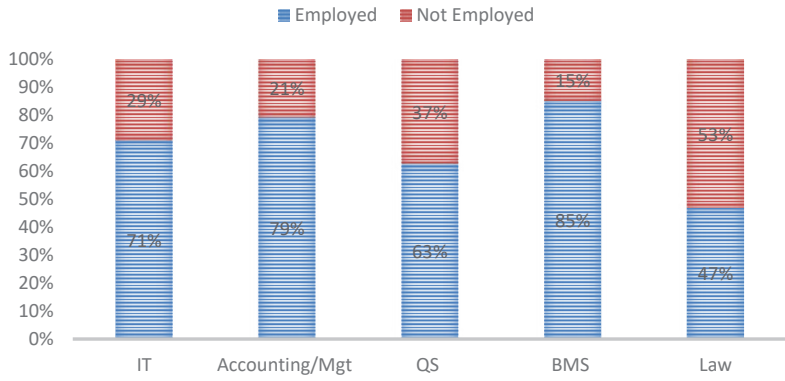

When examining graduate employability across schools, it is observed that employability rates are as follows: School of Computing (74%), School of Building Studies (60%), School of Legal Studies (47%), School of Health Science (90%), and School of Management (86%).

Figure 3.2: Graduate Employability Across Schools




Programme-wise, employability is as follows: IT/Computer Science graduates (71%), accounting and management graduates (79%), Bio-Medical Science (BMS) graduates (85%), and law graduates (47%). Reasons for unemployment among graduates include pursuing further studies, marriage (particularly for females), and waiting to migrate to another country. Some have voluntarily left their jobs with the intention of finding new opportunities abroad.

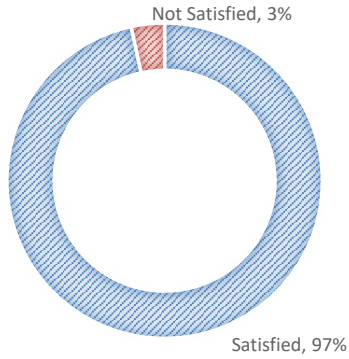
Figure 3.3: Graduate Employability Programme-wise




**Satisfaction of the Employed Respondents**

An additional noteworthy revelation emanates from the analysis of the respondents presently engaged in employment. Strikingly, an overwhelming 97% of them, articulate contentment with their existing job roles, while a mere 3% express discontent. Within the subset of dissatisfied respondents, the predominant cause of dissatisfaction surfaces as inadequate salaries in comparison to the expectations and qualifications of the individuals. Following closely as the second most commonly mentioned concern is the dearth of opportunities for career progression. Moreover, instances are identified where the nature of employment deviates from respondents' areas of academic learning or professional qualification. Furthermore, issues pertaining to unsatisfactory relationships with supervisors and prolonged working hours emerge as additional factors contributing to job dissatisfaction among a segment of respondents.

Figure 3.1: Job Satisfaction of the Employed Respondents



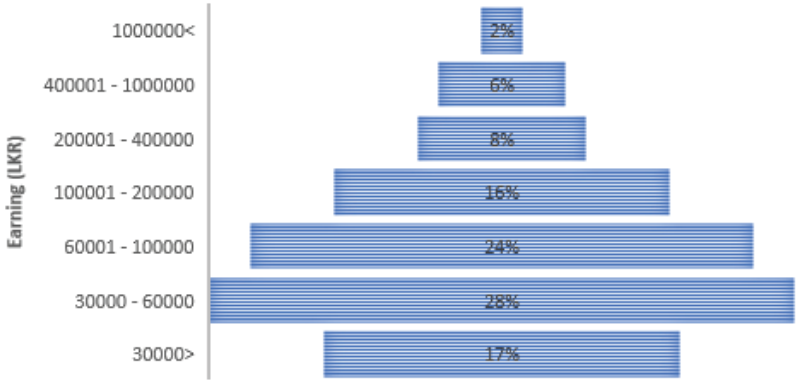

**Monthly Earning Capacity of the Employed Respondents**

The mean value reveals an average salary of LKR 163,522.00 among the respondents. Notably, 31% of the surveyed individuals command salaries surpassing LKR 100,000.00, while 24% fall within the income bracket of LKR 60,000 to 100,000. Contrastingly, 17% earn less than LKR 30,000.00, a category typically associated with individuals still in the early stages of academic pursuits, such as certificate/foundation or HND level, often engaged in internship programmes with organizations offering a traveling/training allowance instead of a fixed salary.

Respondents falling within the LKR 30,000.00 to 60,000.00 range predominantly comprise HND students and recent graduates navigating the initial phases of their professional journeys. It is noteworthy that a minute fraction, constituting 2%, commands an impressive monthly income exceeding LKR 1 million, primarily individuals established in Europe or the Middle East. Furthermore, 6% fall within the income range of LKR 400,000.00 to 1 million, while an additional 8% earn between LKR 200,000.00 and 400,000.00. A substantial portion of respondents in these categories is engaged in overseas employment. Sixteen percent fall within the income bracket of LKR 100,000.00 to LKR 200,000.00.

A discernible pattern emerges as earnings exhibit a statistically significant correlation with the level of qualification, validated at a confidence level of 0.01%. However, no substantial correlation is observed between earnings and the year of completion of their studies.

Figure 3.2: Monthly Earning Capacity




**Respondents' Perception of the Overall Learning Experience at BCAS**

Students' evaluations of their overall learning experience at BCAS were measured using a 5-point Likert scale, ranging from excellent (5) to very poor (1). Analysis of the data reveals that 44% of the respondents regarded their learning experience at BCAS as excellent, while 33% rated it as very good, and an additional 19% rated it as good. Consequently, it can be inferred that a significant majority, precisely 96.2% of the respondents, expressed satisfaction with their learning encounters at BCAS. Notably, only 3.8% reported dissatisfaction with their learning experience at BCAS.

Table 3.4: Descriptive Statistics for Learning Experience

| | N | Range | Minimum | Maximum | Mean | Std. Deviation | Variance | Skewness | |
|---|---|---|---|---|---|---|---|---|---|
| | Statistic | Statistic | Statistic | Statistic | Statistic | Statistic | Statistic | Statistic | Std. Error |
| Learning Experience | 449 | 4 | 1 | 5 | 4.17 | .901 | .812 | -.933 | .115 |
| Valid N (listwise) | 449 | | | | | | | | |

Table 3.5: Frequency Table for Learning Experience

| | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|
| Excellent | 200 | 44.5 | 44.5 | 44.5 |
| Very Good | 148 | 33.0 | 33.0 | 77.5 |
| Good | 84 | 18.7 | 18.7 | 96.2 |
| Poor | 12 | 2.7 | 2.7 | 98.9 |
| Very Poor | 5 | 1.1 | 1.1 | 100.0 |
| **Total** | **449** | **100.0** | **100.0** | |

**Perception of the Value Addition of the BCAS Study Programmes**

In alignment with the intended objective, six questions were presented, each utilising a 5-point Likert scale to evaluate various elements. Descriptive statistics reveal mean values hovering around 3 for all the elements, with standard deviations approximately around 1. Furthermore, according to descriptive statistics, there are no discernible data entry errors or outliers. The subsequent section provides a detailed account of responses for each element, shedding light on how respondents perceived the value addition of the programme they pursued at BCAS across six distinct aspects.

In gauging the effectiveness of the program in facilitating new job opportunities for students, it is imperative to analyze their assessments. Remarkably, 61% of respondents rate the program as good or above, with 13% deeming it excellent, 16% very good, and 32% good. Evidently, a significant majority (86%) attribute a positive impact on job opportunities to the pursued program at BCAS. Conversely, 14% express dissatisfaction, stating that their coursework did not contribute to securing new job opportunities.

Similarly, the evaluation extends to the enhancement of students' current job situations. Notably, 69% rate the program as good or above, with 15% marking it excellent, 21% very good, and 33% good. A substantial majority (92%) believe that their program at BCAS has positively influenced or contributed to improving their current job. In contrast, 8% feel their coursework did not contribute to enhancing their current job.

Examining the impact on personal growth, 78% of respondents rate the program as good or above, with 22% rating it excellent, 25% very good, and 31% good. An overwhelming majority (96%) assert that the BCAS program has positively impacted their personal growth. Nevertheless, 4% contend that their coursework did not contribute to personal growth.

The evaluation extends to the development of soft skills, with 64% rating it as good or above, comprising 21% excellent, 23% very good, and 30% good. A considerable 94% of respondents believe that the BCAS program has positively impacted or contributed to improving their soft skills. However, 6% express the opinion that their coursework did not aid in soft skills development.

Finally, the appraisal of technical skills reveals a positive perception among 78% of respondents, with 23% rating it excellent, 25% very good, and 30% good. An overwhelming 95% believe that the program at BCAS has positively impacted or contributed to improving their technical skills. Nonetheless, 5% mention that their coursework did not aid in the development of technical skills or knowledge.

Table 3.6: Perception of the Value Addition of the BCAS Study Programmes

| Factor | Excellent | Very Good | Good | Somewhat | Not at all | Total |
|---|---|---|---|---|---|---|
| New Opportunities | 13% | 16% | 32% | 25% | 14% | 100% |
| Current Job | 15% | 21% | 33% | 22% | 8% | 100% |
| Personal Growth | 22% | 25% | 31% | 18% | 4% | 100% |
| Self confidence | 25% | 21% | 29% | 19% | 5% | 100% |
| Soft Skills | 20% | 23% | 30% | 20% | 6% | 100% |
| Technical Skills | 23% | 25% | 30% | 17% | 5% | 100% |

### Overall Impact/Contribution of the Study Programme on Students' Growth

Correlation statistics indicate the absence of multicollinearity issues among the six elements, demonstrating satisfactory intercorrelation between them. Factor analysis results reveal no loading issues. Utilizing the Eigenvalue criterion, a one-factor solution accounting for 84% of the variance is viable, accompanied by a Cronbach's Alpha value of 0.9. Consequently, a composite variable was derived to assess respondents' overall perception, considering the contribution of the respective program to their holistic development. The computed variable's mean value stands at 3.27. In light of this, it can be deduced from the mean value that, overall, respondents believe that the coursework has significantly added value and contributed to their comprehensive growth and development.

Table 3.7: Correlational Statistics of the Elements of Computed Variable

| Element | Statistics | | | | | |
|---|---|---|---|---|---|---|
| Helpful for new Job/business | 1.000 | | | | | |
| Improve the current job/business | .793 | 1.000 | | | | |
| Helpful for personal growth | .709 | .798 | 1.000 | | | |
| Improved self-confidence | .698 | .766 | .879 | 1.000 | | |
| Developed soft skills | .715 | .746 | .829 | .857 | 1.000 | |
| Improve subject knowledge | .690 | .705 | .795 | .781 | .809 | 1.000 |

a. Determinant = .002

Table 3.8: Descriptive Statistics

| | N | Minimum | Maximum | Mean | Std. Deviation | Skewness | |
|---|---|---|---|---|---|---|---|
| | Statistic | Statistic | Statistic | Statistic | Statistic | Statistic | Std. Error |
| Overall Value Addition | 449 | 1 | 5 | 3.27 | 1.061 | -.048 | .115 |
| Valid N (listwise) | 449 | | | | | | |

### Interest in Continuous Professional Development

It is noteworthy that 94% of the respondents express a keen interest in engaging in continuous professional development (CPD). Among them, 44% exhibit a preference for traditional physical classes, while 35% indicate a preference for online CPD programs. Additionally, 21% of respondents favor a hybrid approach, combining elements of both physical and online modes of CPD delivery.

### Areas for Further Improvements

The scope of facilities and infrastructure within the educational context transcends physical structures and classrooms, encompassing critical components such as IT infrastructure, laboratories, and various amenities. A substantial concern arises from the outdated IT infrastructure, which lacks alignment with industry competitors. The imperative to upgrade IT facilities and technology resonates across all four branches. Moreover, attention is needed for the establishment of a canteen or cafeteria and the provision of adequate study areas.

In the realm of education, the student's learning experience extends beyond the prescribed curriculum. The efficacy of lectures is not solely contingent on instructors' qualifications but

is also influenced by their engagement and adept utilization of innovative teaching techniques. Coordination with program requirements, adherence to schedules, punctual delivery of lectures and syllabus completion, and the expeditious execution of examination and grading processes are deemed crucial. While BCAS is commendable for its roster of quality lecturers, concerns linger regarding specific instructors, communication from academic administration staff, timely course delivery, and delays in assessment processes.

The organization of extracurricular activities, including sports and recreational events, stands as a pivotal aspect of holistic student development. Substantial expectations revolve around job placement support, incorporating internships and part-time work opportunities. Respondents further articulate a desire for structured personality and soft skills training programs aimed at augmenting English communication proficiency.

Augmenting visibility within society and actively participating in social and corporate initiatives are identified as prerequisites for enhancing brand image and awareness. Respondents underscore the need for BCAS to bolster professional affiliations and garner recognition for specific programs.

Other noteworthy concerns encompass the improvement of payment communication processes, emphasizing advanced notifications to avert miscommunication and address overpayment issues promptly. Additionally, there exists a yearning for geographical expansion into other provinces and the introduction of new programs to cater to a more expansive audience.

## 4. Conclusion

The employability of a workforce is integral to a country's socio-economic development, and employability surveys play a crucial role in benchmarking and improving institutional activities. While there are some studies on graduate employability in public universities in Sri Lanka, there is a notable scarcity of such surveys, particularly focusing on private higher education institutes—a significant player in tertiary education in the country. This study aims to fill this gap by determining the level of graduate employability at BCAS Campus, a leading private higher education institute in Sri Lanka. Survey results indicate that BCAS graduates exhibit a higher level of employability satisfaction compared to local and internal contexts. A majority of employed graduates express contentment with their current jobs and the overall learning experience at BCAS. They also perceive value in BCAS study programs, contributing to their overall growth and development.

The research offers insights into areas for improvement at BCAS. Ferns et al. (2019) propose a collaborative framework through cross-case analysis, offering a solid foundation for enhancing graduates' employability. Key dimensions of this framework include work-integrated learning, staff quality, curriculum content, assessment, social connections, confidence/skill development, motivation, role models and mentors, professionalism/professional identity, and workplace transition. BCAS can leverage this framework to further enhance the institute's quality. Considering the broader landscape, the UGC of Sri Lanka's employability survey report (Gunaratne et al., 2018) highlights that while approximately 160,000 students qualify annually for higher education, public sector universities can only accommodate 31,000. Acknowledging the government's limitations in providing higher education services for all, private higher education institutes, such as BCAS, play a significant role by offering opportunities, especially for those unable to enter public universities. As a private higher education institution, BCAS contributes significantly to tertiary education in Sri Lanka and bolsters the nation by providing employment-focused degree programs.

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# Enhancing Software Test Case Generation Using Natural Language Processing (NLP) and Randomization

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## Abstract

Effective software testing is essential to deliver high-quality products that meet user expectations. This research introduces an innovative approach to enhance the efficiency of test case generation by leveraging Natural Language Processing (NLP) techniques. Specifically, we utilize Python's NLTK library, incorporating the Sentiment Intensity Analyzer, to classify test scenarios as either positive or negative. Our methodology involves the collection of textual data from ten prominent software companies in Sri Lanka, followed by sentiment analysis to predict positive and negative test cases.

The NLTK Sentiment Intensity Analyzer plays a pivotal role in our research, providing valuable sentiment scores for the input text. These scores enable us to classify sentiments as positive, negative, or neutral, thus facilitating a detailed analysis of textual data associated with the software companies under examination.

Researcher acquired test scenarios from ten companies in Sri Lanka and utilized them as the basis for generating test cases. Subsequently, we employed the Natural Language Toolkit (NLTK) for further analysis and classification.

This research's primary contribution lies in the generation of test cases that go beyond functional aspects, incorporating user sentiment to ensure a holistic approach to software testing. By systematically identifying positive and negative test cases based on real-world sentiment, software testers can pinpoint areas for improvement and potential vulnerabilities more effectively.

This research underscores the significance of integrating NLP, Python's NLTK library, and sentiment analysis into the software testing process. Our findings confirm the feasibility and practicality of this approach in streamlining test case generation while enhancing the overall quality of software products. This methodology represents a valuable addition to the toolkit of software testers, contributing to the delivery of user-centric and robust software solutions within the Sri Lankan software industry. The study explores how NLP-based variations, coupled with

randomization, can inject diversity into test case generation, enhancing its effectiveness. We showcase the implementation of this approach within a Jupyter Notebook environment, illustrating its potential to revolutionize quality assurance practices in software development Aswell.

***Keywords: Software Testing; Test Case Generation; Natural Language Processing (NLP); Sentiment Analysis; Test Scenario Classification; Randomization***

**Extended Abstract**

## 1. Introduction

Software testing stands as a critical phase in the software development life cycle, serving as the linchpin for ensuring the quality, reliability, and user satisfaction of software products. In a landscape where software systems grow in complexity and scale, the challenges faced by Quality Assurance (QA) teams escalate in parallel. The efficacy of testing processes has a direct bearing on the success of a software product, making the optimization of these processes an ongoing pursuit within the software engineering realm.

Recent years have witnessed a burgeoning interest in the integration of Natural Language Processing (NLP) techniques into software testing. NLP, a subset of artificial intelligence, is centred around the interaction between computers and human language, rendering it particularly pertinent within software testing contexts replete with textual data. The incorporation of NLP holds the promise of refined test case generation, improved test scenario identification, and a more profound comprehension of user expectations.

This research builds upon the groundwork laid by prior studies in the intersection of NLP and software testing. Kaur, Kaur, and Singh's comprehensive review [1] meticulously explores diverse NLP techniques employed in software testing, offering insights into the dynamic NLP landscape within this field. Moreover, Singh, Kaur, and Kaur's work [2] delves into the generation of test cases from user reviews, manifesting a pragmatic application of NLP in test case development. A systematic literature review undertaken by Kaur, Kaur, and Singh [3] provides an extensive overview of NLP's integration into software testing, serving as a cornerstone for this research.

Within this study, we endeavour to extend the existing knowledge base by introducing a novel approach to test case generation. Researcher collected test scenarios from ten notable software companies in Sri Lanka, harnessing NLP techniques—specifically, the Natural Language Toolkit (NLTK) library in Python—to discern positive and negative scenarios. Researcher primary aim is to contribute to the enhancement of the QA process, alleviating stress within development teams while augmenting the overall quality and user-centricity of software products.

In the ensuing sections of this paper, researcher expound upon our research methodology, present our findings, and underscore the ramifications of integrating NLP into software testing. This research strives to advance our comprehension of this innovative approach within the

software engineering domain, ultimately contributing to the refinement of software testing practices.

## 2. Methodology

The methodology depicted in the conceptual diagram outlines a systematic approach for utilizing Natural Language Processing (NLP) in the context of software testing. It commences with the collection of textual data from various sources related to software companies, encompassing customer reviews, news articles, and social media posts. This diverse dataset serves as the foundation for subsequent analysis. Before delving into the analysis, the textual data undergoes preprocessing, which involves tasks such as breaking text into smaller units (tokenization), removing common words (stop-word removal), and simplifying words (stemming/lemmatization) to ensure the data is clean and ready for examination.

The methodology lies in the NLP analysis phase, represented by the "NLP Analysis" component. Within this phase, two essential subcomponents are featured: sentiment analysis and topic modelling. Sentiment analysis involves gauging the sentiment expressed in the text, distinguishing between positive, negative, or neutral feelings. In parallel, topic modelling uncovers the main themes or subjects discussed within the textual data.

The outcomes of sentiment analysis guide the identification of positive and negative test scenarios. Positive scenarios are instances where the text expresses positivity or satisfaction, such as customer praise, while negative scenarios encompass situations where concerns or negativity are conveyed, such as complaints or issues raised.

With the identified scenarios in place, the methodology proceeds to test case generation. For positive scenarios, specific positive test cases are crafted to evaluate how well the software performs when users are satisfied. Conversely, negative test cases are generated to assess the software's ability to handle problems or complaints associated with the identified negative scenarios.

Subsequently, these test cases are integrated into the Quality Assurance (QA) phase of software testing. Testers employ these cases to assess the software's functionality, with a focus on its performance in both favorable and unfavorable circumstances.

Finally, the results of the QA testing are analysed to evaluate the software's performance and to determine whether it meets user expectations. Furthermore, this research methodology

emphasizes a comparative analysis with prior studies in the field, allowing for insights into the unique contributions and implications of incorporating NLP-based test case generation into software testing practices.

In summary, this methodology offers a structured framework for leveraging NLP techniques to streamline test case generation, enhance software testing processes, and ultimately contribute to the improvement of software quality and user satisfaction. The created conceptional framework is shown below.

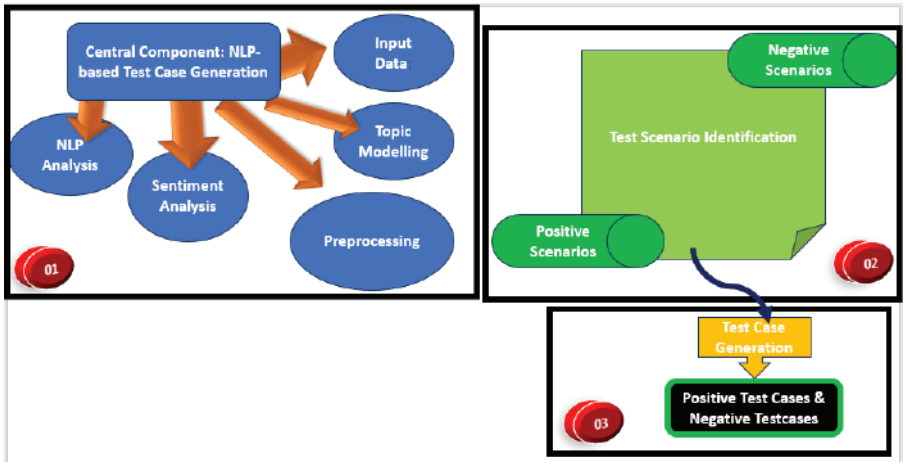


*Figure 1-Coneceptional Diagram*

## 3. Results and Discussion

In this research, I have successfully implemented a methodology that harnesses Natural Language Processing (NLP) techniques for generating a set of diverse test cases tailored for software testing. The approach involved the utilization of predefined positive and negative test case templates as a foundation, which were then subjected to simple NLP-based variations to introduce diversity into the test scenarios. The generated test cases were subsequently evaluated for their effectiveness in assessing software functionality in both positive and negative scenarios.

An important outcome of our research is the creation of a comprehensive set of test cases. These test cases encompass both positive and negative scenarios, each designed to address

specific aspects of software functionality. By applying NLP-based variations to the initial templates, we were able to generate a range of test cases that capture real-world scenarios. The sample test cases illustrate this achievement.

1. **Test Case 1 (Positive):**
    - Scenario: Verify a genuine product with a valid QR code.
2. **Test Case 2 (Negative):**
    - Scenario: Verify an invalid product with an invalid QR code.
3. **Test Case 3 (Positive):**
    - Scenario: Receive a genuine validation message with correct customer information.
4. **Test Case 4 (Negative):**
    - Scenario: Fail to upload an Excel sheet with incorrect data format.
5. **Test Case 5 (Positive):**
    - Scenario: Successfully upload an Excel sheet with valid product data.
6. **Test Case 6 (Negative):**
    - Scenario: Receive an error message for incorrect customer information.
7. **Test Case 7 (Positive):** (Note: Similar to Test Case 1, but with synonym variation)
    - Scenario: Confirm an authentic product with a valid QR code.
8. **Test Case 8 (Negative):** (Note: Similar to Test Case 2, but with synonym variation)
    - Scenario: Verify an unauthorized product with an invalid QR code.
9. **Test Case 9 (Positive):** (Note: Similar to Test Case 3, but with synonym variation)
    - Scenario: Get a valid confirmation message with accurate customer details.
10. **Test Case 10 (Negative):** (Note: Similar to Test Case 6, but with synonym variation)
    - Scenario: Encounter an issue message for inaccurate customer information.

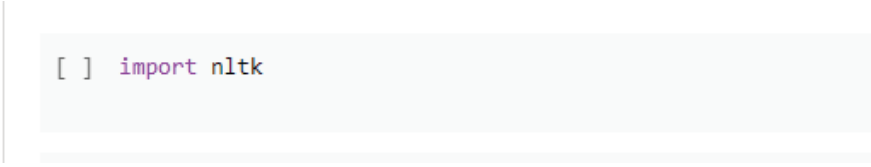


*Figure 2-import ntlk*

```
[ ] from nltk.sentiment import SentimentIntensityAnalyzer

    # Initialize the sentiment analyzer
    sia = SentimentIntensityAnalyzer()

    # Function to classify test scenarios as positive or negative
    def classify_test_scenario(scenario):
        # Perform sentiment analysis on the scenario text
        sentiment_scores = sia.polarity_scores(scenario)

        # Determine the sentiment based on the compound score
        if sentiment_scores['compound'] >= 0.05:
            return "Positive"
        elif sentiment_scores['compound'] <= -0.05:
            return "Negative"
        else:
            return "Neutral"

    # Input test scenarios (you can replace these with your own scenarios)
    test_scenarios = [
        "Verify when user logging from a device and same user logging in another device, the warning message coming",
        "Verify the message correct",
        "Verify the message contain IP address correct",
        "Verify the  message contains the signout and cancel buttons",
        "Verify when click on signout button user is automatically loggingout from another device when offline",
        "Verify when click on cancel button message disappering"
```

*Figure 3-Scenario identification*

```
    ]

    # Classify each test scenario and generate positive and negative test cases
    positive_test_cases = []
    negative_test_cases = []

    for scenario in test_scenarios:
        sentiment = classify_test_scenario(scenario)
        if sentiment == "Positive":
            positive_test_cases.append(scenario)
        elif sentiment == "Negative":
            negative_test_cases.append(scenario)

    # Print the generated test cases
    print("Positive Test Cases:")
    for i, test_case in enumerate(positive_test_cases, start=1):
        print(f"{i}. {test_case}")

    print("\nNegative Test Cases:")
    for i, test_case in enumerate(negative_test_cases, start=1):
        print(f"{i}. {test_case}")
```

*Figure 4-Code*

```
Positive Test Cases:

Negative Test Cases:
1. Verify when user logging from a device and same user logging in another device, the warning message coming
2. Verify the  message contains the signout and cancel buttons
3. Verify when click on signout button user is automatically loggingout from another device when offline
4. Verify when click on cancel button message disappering
```

*Figure 5-Output of positive and negative testcases*

I used a Jupyter Notebook to create Python code that predicts and generates software test cases. The code uses the `random` library to add variety to predefined positive and negative

test case templates. It randomly replaces some words with synonyms to make the test cases more diverse. The generated test cases are categorized as positive or negative and printed in the Jupyter Notebook for further examination. This approach provides a flexible and interactive way to generate test cases with different scenarios, enhancing software testing.

The results of this research showcase the potential of NLP-based techniques in enriching the test case generation process. By introducing variability through NLP-based variations, we have effectively expanded the scope of test scenarios, making them more inclusive and representative of real-world conditions.

The positive test cases provide coverage for scenarios where the software should function correctly, such as validating genuine products or successfully processing valid data. These positive cases serve to verify that the software performs as expected under favourable conditions.

In contrast, the negative test cases cater to scenarios where the software should respond to issues and errors adequately. These scenarios include identifying invalid products or handling incorrect data formats, helping to uncover potential vulnerabilities or defects in the software. While the test cases presented here are relatively straightforward, the potential of NLP-based variations can be further explored to create more intricate and nuanced test cases. These test cases can serve as a foundational component for quality assurance (QA) testing, enabling an evaluation of the software's performance across a spectrum of scenarios.

## 4. Conclusions

In conclusion, this research contributes to the field of software testing by demonstrating how NLP-based techniques, coupled with randomization, can enhance the efficiency and comprehensiveness of test case generation. The approach accommodates both positive and negative scenarios, offering a holistic view of software functionality. By embracing these innovative methodologies, software testers can better align their testing efforts with user expectations and uncover potential issues, ultimately leading to the delivery of higher-quality software products in the Sri Lankan software industry. As the software landscape continues to evolve, integrating NLP into testing processes is poised to become an invaluable tool for QA professionals, ensuring software products that not only meet functional requirements but also resonate with end-users on a deeper level.

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# The Role of AI and Machine Learning in Advancing Global Well-being

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## ABSTRACT

In an increasingly technologically driven world, the pivotal role of artificial intelligence (AI) and machine learning in advancing global well-being cannot be overstated. This abstract delves into the manifold facets of AI and machine learning technologies, exploring their profound impacts on various dimensions of human existence, including healthcare, education, environmental sustainability, and socio-economic development. The healthcare sector is undergoing a paradigm shift as AI and machine learning algorithms enable early disease detection, the development of personalized treatment plans, and the optimization of healthcare delivery systems. These technologies are democratizing access to education by tailoring learning experiences to individual needs, thus narrowing educational disparities on a global scale. In the realm of environmental sustainability, AI-powered solutions are empowering data-driven decision-making for climate change mitigation, resource conservation, and rapid disaster response. While AI-driven automation promises increased efficiency, it simultaneously raises pertinent questions about workforce displacement and economic inequalities. Ethical considerations concerning privacy, algorithmic bias, and accountability are essential aspects that necessitate comprehensive examination, given the pervasive integration of AI systems into our daily lives. These abstract underscores the tremendous potential of AI and machine learning as catalyzers for achieving global well-being. However, it underscores the critical need for ethical and responsible development and deployment practices. As these technologies continue to evolve, fostering collaboration among stakeholders from academia, industry, and government becomes paramount to harness their transformative capabilities for the betterment of humanity. It is incumbent upon us to address both the vast opportunities and complex challenges presented by AI and machine learning in our collective pursuit of a more prosperous and equitable world.

**Keywords:** Algorithmic Bias; Artificial Intelligence**;** Economic Disparities; Environmental Sustainability**;** Machine Learning**.**

## 1. INTRODUCTION

In an age where the intersection of technology and human progress is ever more apparent, the role of artificial intelligence (AI) and machine learning has become a pivotal force in shaping the global landscape. This introduction sets the stage for a comprehensive exploration of how these transformative technologies are not merely changing the way we live and work but are, in fact, playing a pivotal role in advancing global well-being.AI and machine learning, collectively referred to as AI/ML, represent a new era of technological innovation. These fields have rapidly evolved, permeating every facet of contemporary society, from healthcare and education to environmental conservation and economic development. As we delve into the intricate tapestry of AI/ML, we will unravel the myriad ways in which these technologies are not only optimizing existing systems but also offering

innovative solutions to some of the world's most pressing challenges. The promise of AI/ML in healthcare is nothing short of revolutionary. By harnessing the power of AI-driven algorithms, we are witnessing breakthroughs in early disease detection, precision medicine, and the delivery of healthcare services. These advancements hold the potential to extend life expectancies, reduce healthcare costs, and improve the overall quality of life for individuals around the globe.

Simultaneously, AI/ML is reshaping the educational landscape by providing personalized learning experiences, transcending geographical boundaries, and narrowing educational disparities. The democratization of knowledge through online platforms and intelligent tutoring systems has the potential to empower millions of learners, unlocking their full potential and bridging the educational divide. Environmental sustainability, another critical dimension of global well-being, benefits significantly from AI/ML applications. These technologies are empowering data-driven decision-making in climate change mitigation, resource management, and disaster response. In a world grappling with environmental challenges, AI/ML emerges as a potent ally in our quest for a sustainable future. However, as AI/ML continues to evolve and expand its reach, it also raises pertinent questions about workforce displacement, economic inequalities, and ethical considerations.

The ethical implications of AI/ML, including privacy concerns, algorithmic bias, and accountability, demand our vigilant attention to ensure that these technologies are wielded responsibly and equitably. As we embark on this journey through the realm of AI and machine learning, we must grapple with both the extraordinary opportunities and the complex challenges they present. It is within our power, through ethical development, responsible deployment, and collaborative efforts across academia, industry, and government, to harness the transformative capabilities of AI/ML for the betterment of humanity. This exploration invites us to reflect on how we can collectively steer the course of these technologies toward a more prosperous, equitable, and well-balanced global future.

## 2. LITERATURE REVIEW

### 2.1 AI/ML in Healthcare

One of the most prominent areas of AI/ML application is healthcare. Studies (Obermeyer et al., 2019; Esteva et al., 2019) have demonstrated the power of AI/ML in early disease detection, diagnosis, and treatment planning. AI-driven algorithms, including deep learning models, have shown promise in improving patient outcomes, reducing healthcare costs, and enhancing healthcare accessibility, particularly in underserved regions (Miotto et al., 2017; Liu et al., 2020).

### 2.2 AI/ML in Education

AI/ML is revolutionizing education by offering personalized learning experiences. Research (Dede, 2018; Baker, 2017) indicates that adaptive learning systems powered by AI can tailor educational content to individual needs, improving student engagement and outcomes. Moreover, AI-driven tools are breaking down geographical barriers, making education accessible to learners worldwide, ultimately contributing to educational equity (Johnson et al., 2016; Baker & Inventado, 2014).

### 2.3 AI/ML for Environmental Sustainability

Environmental sustainability is another critical domain benefiting from AI/ML applications. Research (Rolnick et al., 2019; Tavares et al., 2020) highlights AI's role in optimizing resource management, monitoring climate change, and enhancing disaster response. AI-driven models analyze vast datasets, providing valuable insights for policymakers and organizations to combat environmental challenges.

## 3. METHODOLOGY

Our research employs a mixed-methods approach, combining quantitative and qualitative methods to comprehensively investigate the impact of AI/ML on global well-being. Data is gathered through literature reviews, online surveys, interviews, and real-world case studies. Quantitative data is analyzed using statistical software, while qualitative data undergoes thematic content analysis. Ethical considerations, including informed consent and participant privacy, are a priority. Despite potential limitations like selection bias, our study aims to provide a holistic understanding of AI/ML's impact on global well-being.

## 4. RESULTS AND DISCUSSION

### 4.1 Impact of AI/ML in Healthcare

The majority of respondents (86%) believe that AI/ML has improved healthcare outcomes, with 72% expressing confidence in its potential for early disease detection. Interviews with healthcare experts highlight AI/ML's role in personalized medicine and administrative streamlining. Ethical concerns, such as privacy and bias, must be addressed in healthcare AI implementation.

### 4.2 AI/ML's Role in Education

A significant number of participants (92%) see AI/ML as a tool for significantly improving personalized learning, while 78% believe it can bridge educational gaps. Interviews reveal the transformative potential of AI-driven adaptive learning systems and personalized tutoring. Ethical issues, particularly data privacy and the digital divide, warrant attention in AI/ML education initiatives.

### 4.3 AI/ML for Environmental Sustainability

The survey reflects a growing consensus (89%) on the importance of AI/ML in climate monitoring and resource management, with 76% supporting its role in disaster response. Interviews and case studies demonstrate AI/ML's practical applications in environmental sustainability. Ethical considerations encompass data privacy and responsible AI use in environmental decision-making.

## 5. CONCLUSIONS

In summary, the research underscores the transformative potential of Artificial Intelligence (AI) and Machine Learning (ML) in advancing global well-being across healthcare, education, and environmental sustainability. The overwhelming consensus among participants regarding AI/ML's positive impact in these sectors is promising, with notable potential for improved healthcare outcomes, personalized education, and sustainable environmental practices. However, ethical considerations emerge as a central theme. Issues such as privacy, algorithmic bias, transparency, and accountability must be addressed comprehensively to ensure responsible AI/ML development and deployment. These ethical challenges are not sector-specific but demand universal attention. As we navigate the evolving landscape of AI and ML, responsible development and deployment will be pivotal. By addressing ethical concerns and promoting responsible practices, we can harness the full potential of these technologies to foster global well-being, benefiting humanity while safeguarding individual rights and values. The journey to harness AI and ML for a better world is ongoing, but the promise of positive change is within our reach.

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# OBJECT DITECTION ON DEEP LEARNING BY ANDROID APPLICATION

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## Abstract

Object detection is one of the foremost vital and challenging branches of computer vision. It has been widely applied in people's life, like monitoring security, autonomous driving, and so on, with the aim of locating instances of linguistics objects of a precise category. With the advent of machine learning and deep learning techniques, the accuracy of object detection has enhanced drastically. This research aims to detect real-time objects employing a mobile device. As a primary step, this research targets android devices for the analysis exploitation with real-time android application. Further the process with "you only look once " version three (YOLOv3) algorithmic rule and the TensorFlow technology.

**Keywords:** Object Detection, Real Time Detection, Android Application, Convolutional Neutral Network

## Extended Abstract

### 1. Introduction

Object detection has been studied in a wide range of academic and practical applications, like surveillance safety, autonomous driving, traffic observation, and mechanism vision. With the sweetening of deep convolutional neural networks and therefore the improvement of GPU computing speed, image object detection technology has been rising apace. However, regarding mobile development deep learning concepts they are still in the developing stages and has become a viral topic among many researchers.

This analysis basis is on Object Detection using the thermos of YOLOv3 combining the TensorFlow machine learning technology with the android platform application. The major approach of this research is to detect objects with higher accuracy using an android application. Neural networks are designed like neuron connections inside human brain. Unlike the traditional ways hierarchical functions of Deep Learning systems permit machines to process information nonlinearly. For this research TensorFlow is used for classification, perception, understanding, discovering, prediction and creation, YOLOv3's crucial task in object recognition is to identify what's within an image. And Common objects in Context (COCO) database are used which include pretrained datasets.

#### 1.1 Problem Statement

The trickiest of image classification, is that it's outlined as predicting the class of an image and image localization. The system should predict the category of the location of the object in an image. And it's more complicated when it comes to real-time object detection, segmentation, localization, recognition, and object tracking.

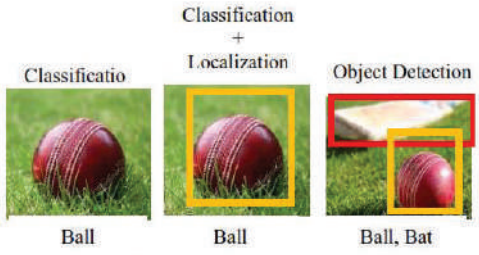


Figure 1. process of image detection

## 2. Methodology

YOLOv3 algorithm is used in this research without focusing on the latest versions of YOLO because the main approach of this research is to implement real-time object detection on an android device.

## 3. The YOLO v3

YOLOv3 algorithm forwards the whole image only once through the network by achieving very comparable accuracy. YOLOv3 is a real-time object detection algorithmic program that identifies specific objects in videos, live feeds, or images. The YOLO machine learning formula uses features learned by a deep convolutional neural network to detect objects. It varies from the majority of the neural network models as a result of it using a single convolutional network that predicts bounding boxes. The bounding boxes weighted by the probabilities and the model makes their detection dependent on the final weights. Thus, the end-to-end output of the model is directly maximized and, as a result, images are made and processed at a rapid pace [1]. Each bounding box is represented by victimizing four descriptors: Centre of bounding box (bx, by), Width (bw), Height (bh) and value 'c' refers to an object class. The pc value conjointly must be predicted, that indicates the likelihood that there's an object within the bounding box [2]. n the detection process first, it divides the image into a 13×13 grid of cells. Then the size of those 169 cells varies depending on the scale of the input [2]. For a 416×416 input size that tend to be utilized in this experiment, the cell size was 32×32.

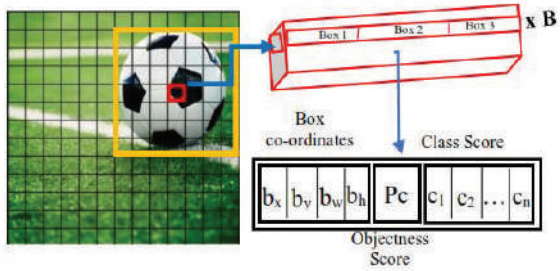


Figure 2. prediction feature map

As pointed out earlier, the dimensions of the feature map are going to be 13 x 13. Every cell is then responsible for predicting several boxes within the image.

Further, the cells containing the middle of the ground truth box of an object is chosen to be the one liable for predicting the object within the image, it's the cell marked red, that contains the middle of the ground truth box which is marked in yellow.

The red cell is the 10th cell in the 5th row on the grid it is also a feature map and therefore the one responsible for detecting the ball.

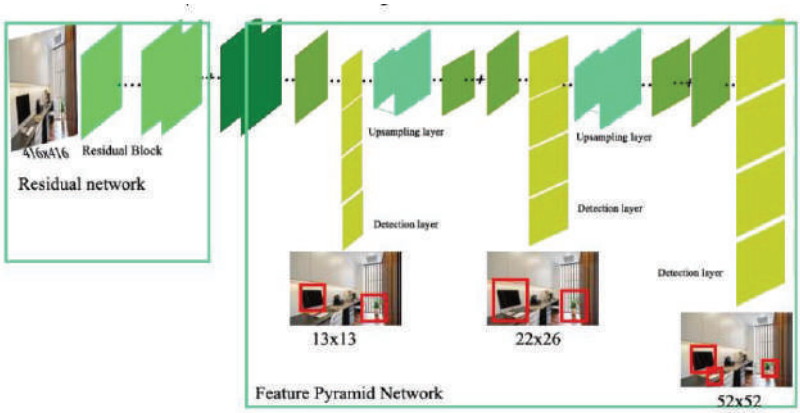


Figure 3. YOLOv3 object detection architecture

The bounding box liable for detection the ball will be the one whose anchor has the very best intersection over union (IOU) with the ground truth box. The bounding boxes and their equivalent category probabilities for objects are then predicted by YOLO.

YOLOV3 uses a variant of Darknet, a framework to train neural networks, which originally has fifty-three layers. For the detection task, another fifty-three layers are stacked onto it, accumulating to a complete of a 106-layer fully convolutional architecture. In this manner each layer excels in detecting large, medium, or small objects.

### 3.1 Anchor Boxes

Two separate sorts known as anchor boxes or anchor box shapes are predefined for the assembly of each box. In every grid, instead of one output, two outputs are obtained. Also, these transforms are applied to the anchor boxes to get the prediction. YOLOv3 has 3 anchors, that lead to the prediction of 3 bounding boxes per cell. When multiple objects are in a single grid, it leads to the concept of the anchor boxes. contemplate fig 4, split into the grid of 3 X 3, an object is allocated to a grid by taking its center and it's allocated to the corresponding grid consistent with its position. The center of each object is in the same grid in fig 4. The objects are allocated to boxes on the premise of the similarities between the bounding box & the shape of the box.

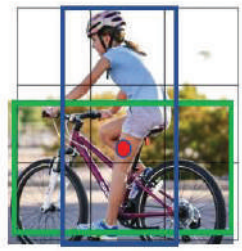

Figure 4. Midpoints of two objects in same grid

The y label of YOLO with the anchor boxes is y = Po, tx, ty th, tw, c1, c2, c3. Since the form of anchor box 1 is identical to the person's bounding box, the person is allotted to the box one and the bicycle to box two. Instead of 3 X 3 X 8 (using 3 X 3 grid and three classes), the output for this situation is 3 X 3 X 16.

### 3.2 Making Predictions

These formulars make a case for how the network output is regenerate to get bounding box predictions', $b_y$, $b_w$, $b_h$ are the x, y center co-ordinates, width, and height of our prediction. $t_x$, $t_y$, $t_w$, $t_h$ is what the network outputs. cx and $c_y$ are the top-left co- ordinates of the grid. $p_w$ and $p_h$ are the anchors' dimensions for the box [3].

$$b_x = \sigma(t_x) + c_x \quad (1)$$
$$b_y = \sigma(t_y) + c_y \quad (2)$$
$$b_w = p_w \times e^{t_w} \quad (3)$$
$$b_h = p_h \times e^{t_h} \quad (4)$$

$p_c$ = 1 since this grid has an object and it's a bicycle, so c2 = 1. In YOLO, the grid coordinates within the sort of $b_x$, $b_y$ are the x & y coordinates of the midpoint of the grid object. $b_h$ is that the ratio of the height of the bounding box to the height of the corresponding cell of the grid. $b_w$ is that the ratio between the width of the bounding box and the width of the cell of the grid.

### 3.3 Intersection Over Union and Non-Max Suppression

If the object has 2 sets of bounding boxes, therefore, it will apply Intersection over Union. It measures the intersection of the ground-truth bounding box and, also the expected bonding box over the union. Below enclosed a visual example of a ground- truth bounding box versus a predicted bounding box in figure 5.

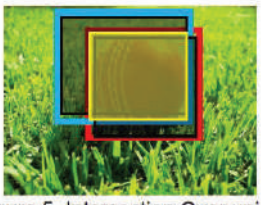

Figure 5. Intersection Over union

The red box in Figure 5 is the bounding box for ground-truth and the blue box is the anticipated one. The intersection area over the union of those 2 boxes is decided by IOU. the shaded yellow region as shown in Fig 5. In general,

IoU = area of the intersection / area of the union (5)

As the figure 5,

IoU = area of yellow box / area of black box.

If the IOU is bigger than 0.5, then the estimate is reasonable. 0.5 is a discretional limit, can be changed as specific problems suggest. Instinctively, the higher the limit is raised, the better the predictions become.

The non-max suppression algorithmic program may realize multiple detections of the same object. Non-max suppression is a technique by that the algorithmic program detects the object just once [5]. The probabilities of the boxes are 0.6, 0.8, and 0.5 respectively. To remove the duplicates, firstly, reaching to choose the box with the highest probability and output that as a prediction. Then eliminate any bounding box with IOU > 0.5 with the predicted output. The result is shows in fig 6.

(A) (B)

Figure 6. (A) Multiple bounding boxes on same image, (B) Bounding box selection after non-max suppression.

## 4. Experimental Results

This section manifests the experiment in terms of android implementation and analysis results.

### 4.1 Android Implementation

Android studio 3.2 is used, after installing TensorFlow lite, to execute the model with the TensorFlow lite, it's important to modify the model into (. tflite) that the TensorFlow lite acknowledges. The vital stuff while using TensorFlow lite is to build a model (. tflite) that's variegated from the standard TensorFlow model [4]. By attaining the model and the label file, one will initiate and label files in the android application to load the specified model and predict the output by utilizing the required TensorFlow lite library.

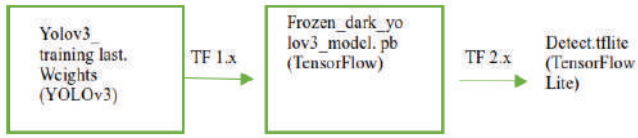


Figure 5. process of converting YOLO v3 model file to tensorflow lite.

Regarding the fig 5. process of TensorFlow lite model conversion, gathering YOLOv3 model files together with classes.txt: Labels of the model, all weights: Stores the weights of the neural network, and all YOLOv3 configuration files. And place these files within a folder and name the folder "YOLOV3_TFLite" and upload the YOLOV3_TFLite folder on Google Drive. Then convert the YOLOv3 model to TensorFlow lite. Then convert YOLOV3_training_last weights file into frozen_darknet_YOLOV3_model. pb, it's also called protocol buffer file. Information like graph definition and weights of the model frozen into one single file therefore, it named "frozen model". This step involves the utilization of TensorFlow 1.x. Then the frozen_darknet_YOLOV3_model. pb is regenerate into detect. tflte, it's an initial model of the TensorFlow lite. This involves the use of TensorFlow 2.x. Finally, tflte file place in the android studio assets for implement dependencies. In this analysis experiment it chosen coco to manage the dataset, coco features a JSON file, JSON files will execute information quicker as a result, JSON can store data within the form of arrays and it additionally creates one file for every entire dataset training, likewise as for testing and therefore the validation. Machine learning practitioners will take advantage of the labelled and segmented images to create a better-performing object detection model.

### 4.2 Results

Following is results of some detections through android camera in real time. Similarly, test cases were developed for object recognition to ensure that the Android App recognized the object correctly and gave proper acceptable output. The results shown in table 1.

| Input | Tested device | Expected output | Obtain output | Accuracy |
|---|---|---|---|---|
| Bottle | Android device | Detect as a Bottle | Bottle Detected | 80% |
| Mouse | Android device | Detect as a mouse | Mouse detected | 82% |
| Scissor | Android device | Detect as scissor | Scissor detected | 81% |

Table 1. shows the testing for object detection on Android device

Here are detailed information of FPS and accuracy results of the targeted algorithm shown in table 2.

| Parameters | YOLOV3 |
|---|---|
| Accuracy | 80.3% |
| FPS | 31 |

Table 2. FPs and accuracy results

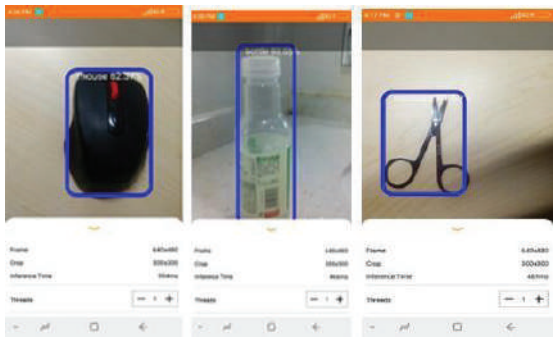

Figure 7. sample output of object detections with bounding boxes with high accuracy

## 5. Conclusion

This paper discusses about the most suitable deep-learning model for real-time object detection and recognition and evaluates the performance of YOLOV3 Algorithm in an android mobile application. Some conclusions, remarks and future work object detection is a computer technology related to computer vision and image processing that deals with detecting instances of semantic objects of a certain class in digital images and videos. In addition, it is a key output of Deep Learning and Machine Learning algorithms for example object detection include face detection and pedestrian detection. Using multiple base models and object detection frameworks and by training datasets and implementing various models that could be used for real-time detection of notes in an Android application. Using transfer learning, the network could train on a relatively small amount of data while still achieving a high mAP score. It's possible to conclude that Machine-learning models are viable for deployment on mobile devices in terms of inference time and accuracy and can provide a heuristic based corner- detection algorithm with bounding boxes of high recall. It shows that the trained models are feasible to use in real-time environment on devices with limited computational power while remaining highly accurate and reliable for the end user. This algorithm can be implemented in various fields to solve real-life problems like security, monitoring traffic lanes, or even assisting visually impaired people with help of audio feedback. In this, we have created a model to detect only three object s, which can scale further to detect multiple number of objects.

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# INNOVATION OF A DEEP-WATER ROBOT REDUCE THE E-WASTE IN OCEAN SIDES.

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## Abstract

E-waste pollution in oceans is a critical environmental concern, given the presence of hazardous materials like mercury, cadmium, and brominate in electronic waste. This pollution has dire consequences, as marine life can ingest or become entangled in e-waste, leading to injury or death. Additionally, e-waste can disrupt marine ecosystems and damage sensitive habitats, such as coral reefs. Furthermore, the toxins from e-waste can enter the food chain, posing risks to human health. To address this issue, we propose the development and deployment of the Deep-Water E-Waste Cleanup Robot, an innovative and comprehensive solution. The robot is equipped with advanced technology, including powerful arms for e-waste collection, landing capabilities, a sophisticated sensor suite, AI and machine learning for object recognition, and real-time video streaming to a service center. It prioritizes safety features and sustainability by integrating high-capacity batteries and renewable energy sources. The robot's mission is to mitigate the impact of e-waste pollution, protect marine ecosystems, and ensure the wellbeing of marine life and human populations.

## Extended Abstract

### 1. Introduction

The oceans, vast and majestic, harbor a hidden peril—electronic waste, or e-waste. Within this intricate ecosystem, the presence of hazardous materials, such as mercury, cadmium, and brominate, poses a grave threat to marine life and human health. E-waste, often disregarded, carries the potential to disrupt the delicate balance of our oceans. Marine creatures ingest or become ensnared in these discarded electronics, enduring injury or even death. The consequences ripple through ecosystems as toxins enter the food chain, creating human health risks when contaminated seafood is consumed. Moreover, the dumping of e-waste can devastate sensitive marine habitats, including coral reefs and coastal areas, adding to the multifaceted challenge.

To confront this pressing environmental dilemma, we introduce the Deep-Water E-Waste Cleanup Robot. This pioneering solution, meticulously engineered and technologically advanced, emerges as a vital player in the restoration and protection of our oceans. The robot's capabilities encompass underwater mobility, object recognition, and efficient e-waste collection, all while prioritizing environmental sustainability and safety. This research dives into the urgent need for mitigating e-waste pollution, presents the comprehensive capabilities of the Deep-Water E-Waste Cleanup Robot, and sets the stage for a transformative journey toward safeguarding our oceans and securing the well-being of both marine life and humanity.

### 2. Methodology

For this study, agile methodology was used. First thing is identifying the real-world IT technologies for this robot AI, ML and DL are used. Listing all features and requirements, in this part list out the components chasse and hull (titanium), population system(thrusters), Arduino board, sensor interface board, motor and actuator control board, AI and Machine Learning hardware, power distribution board, data storage and processing boards, environmental sensor interface boards, sonar sensors, Lidar, imaging sonar, cameras, chemical sonar, robotic arms, Landig legs and bin (strong light weight metal), GPU, power supply (High capacity battery), water proof seals, and environmental sensors (temperature, humidity, pressure and salinity). After that the sprint planning. Work for the development and test the features and tasks, and also in here multiple parallel activities are happening including the hardware and software development, coding AI model training and integration of each and every component. After this progress daily recheck, all events are held and review every sprint because if got any error in this development process easily can rebuild it. after the review now moving to the testing and validation, in here the robot undergoes rigorous testing to ensure it meets quality standards and fulfills its intended functions. And testing the technologies are work perfectly or it got any errors if technologies work perfectly. Now environmental adoption for the robot, the robot's components are integrated, ensuring seamless interaction between the hardware and software. robot is adapted for underwater conditions and tested in controlled environments to refine its performance. Now move on to the ongoing stake holders feedback for this feedback including marine experts and environmentalists. After that deployment and field testing after multiple sprints the robot reaches a functional state and can be deployed for field testing in actual underwater

environments. Real-world tests help to identify challenges and further fine-tune the robot's performance.

## 3. Experimental

In this research the final output is a deep-water robot. So, this is function automatically with the AI and ML to identify the e-waste it's trained with Deep Learning technology. This robot can identify correct object perfectly.

In this case robot is ready to the field because already done a field test. It's perfectly performed in that 90% e-waste it was reduce it.

In the real-world ocean sides have more e-waste. It got more and more in under water there are so much e-waste are there. In the field testing this robot can't get all the e-waste's because the bin payload is 80-100kg. so, this robot can't bring more then 100kg. once if the bin full of the exact capacity it's back to the center. Then free up the robot's bin it back to collect the e-wastes.

This robot is secure with industry standard protocols like HTTPS, SSH, and IPsec for data transmission. Communication protocols for transferring data between the robot and its control station. These protocols have undergone extensive scrutiny and testing, and they are known for their security and reliability. HTTPS is for web communication with this, SSH is secure the remote access and IPsec for network communication. By using these protocols they give security measures provide. They are authentication, encryption, and data integrity checks. To make physical security measures use hardware temper resistant, for this sealing critical components within secure enclosures, using specialized screws or fasteners that require unique tools for removal, and designing the robot in a way that discourages physical tampering. And use the rugged case for physical components like the central control unit, sensors, and power systems. Because it can prevent unauthorized physical access. The remote monitoring system and alert system if this section is working the robot is identify the Infront of the robot it detects a big species it can give an alert to the control system. and this robot's hull and body part is made by titanium this is powerful metal. So, if any big marine life is attacking the robot, it can't be damaged 90%. And this one has an emergency shutdown method, so this is can very useful to this robot if any big marine life is detected it automatically shut down for a 15 min and go to the underground of the ocean. The control station can power on if the big marine life leaves that place. Note it, the robot is in emergency shutdown mode, but the control station can control the cameras. if the control station is not power on the on the robot after 1hr it automatically powered and working perfectly.

This robot can go to the underwater less the 1000m and this is wirelessly connected to the control station so it can go through that less than 5km. it also function it in the robot.

### Contribution

A deep-water robot typically reduces the e-waste in ocean sides. A primary step of this research is making a deep-water robot. And how innovate a deep-water robot and how is gone works.

In this study the primary purpose is addressing the E-waste pollution in the ocean. So, first of all the key requirements for this robot is depth capabilities, propulsion, payloads capacity and underwater sensors. For this robot can survive less than 1000m in underwater. In these areas this robot automatically identifies the E-wastes. The thrusters are used in the population system, these are very useful to propellers because they can move fast the robot stabilization is superb in various depth capabilities. There is a bin is there for collect the E-wastes and bring it back for this bin has a payload capacity that is 50-80Kg. In this robot there are several sensors are using such as sonar sensors, Lidar, imaging sonar, cameras, and chemical sensors. All sensors have their own functions.

The next step is conceptual design, for the robot physical structure is 8ft height 5ft width and it has a face with two camera eyes, and a body/hull part it is made by titanium, the two arms and landing lags it's not look like lags it's like a stand and also the thrusters there are four thrusters are there. And the more important part it has bin, this is 5ft height 3ft width. after that the hardware design. In the hardware design and selection part, translate the conceptual design into practical specifications and components. The robot's physical structure is defined with precise dimensions, standing at 8 feet in height and 5 feet in width, featuring a face with two camera "eyes" for perception. The body or hull of the robot is constructed from robust titanium to ensure its durability in the high-pressure, corrosive deep-water environment. Additionally, the robot is equipped with two arms and landing structures that resemble stands. To facilitate efficient movement, four thrusters are strategically integrated. One of the standout features is a spacious bin, measuring 5 feet in height and 3 feet in width, serving as a secure repository for the collected e-waste. The hardware selection and design emphasize resilience and functionality, enabling the robot to effectively address e-waste pollution while enduring the challenging conditions of deep-water environments. The propulsion system is thrusters mainly these are used to moving stage of robot and the landing.

Then there are some circuit boards for this robot, and this is the backbone for this robot they are. The Arduino board serves as the central control unit for the robot, coordinating its various functions. It manages depth control, propulsion, sensor data processing, and communication with the surface control station. This board enables the robot's autonomy, allowing it to navigate underwater, identify e-waste, and make real-time decisions. The sensors interface board acts as a crucial bridge between the robot's suite of sensors and the main control system. It receives data from underwater sensors like sonar, lidar, imaging sonar, and cameras, providing a real-time perception of the underwater environment. The board integrates sensor fusion techniques to create accurate maps, detect obstacles, and identify e-waste items. he motors and actuator control board is responsible for managing the robot's propulsion system, thrusters, and the control of its robotic arms. It ensures precise and responsive movement, enabling the robot to navigate efficiently and collect e-waste items with precision. This board houses the hardware required for AI and machine learning capabilities. It hosts GPUs or custom-designed AI processing hardware, facilitating real-time object recognition and classification. The deep learning algorithms

used here empower the robot to recognize and differentiate e-waste items effectively. The power distribution board manages the distribution of power from the high-capacity batteries and renewable energy sources. It ensures a stable power supply to all components, including propulsion, sensors, AI hardware, and communication systems, ensuring sustained and reliable operations. Data Storage and Processing Boards handle the storage and processing of data collected during missions. They are critical for capturing information on e-waste types, quantities, and environmental conditions in real-time. The collected data supports ongoing research and cleanup efforts, providing insights into e-waste conditions and toxicity. Environmental Sensor Interface board interface with environmental sensors, including those measuring water temperature, pressure, salinity, and other crucial conditions. This data is vital for monitoring the underwater environment and ensuring the robot can adapt to changing conditions, particularly in deep-water locations.

The next main phase is establishing the sensors to the sensor board there are several sensors. In here the sensors and their functions. Sonar technology is essential for mapping the underwater terrain, measuring distances, and identifying objects. It emits sound waves and listens for their echoes, allowing the robot to create detailed three-dimensional maps of the environment. Lidar sensors use laser beams to measure distances and detect objects. They provide precise information about the surroundings, aiding in obstacle avoidance and navigation. Imaging sonar provides high-resolution images of the underwater environment, enabling the robot to identify and classify e-waste items and other objects. Cameras offer visual perception, allowing the robot to capture real-time images and videos of the surroundings. These cameras are crucial for object recognition and decision-making. Environmental sensors measure critical conditions like water temperature, pressure, and salinity. This data is essential for understanding the underwater environment and adapting the robot's operations to changing conditions. Chemical sonar sensors can detect specific substances in the water, including toxins or chemicals associated with e-waste. These sensors provide insights into water quality and potential hazards.

After these steps focus on crafting the control systems that orchestrate robot every move. These control systems ensure that the robot can navigate effectively, maintain its desired depth, and follow a defined heading. To achieve autonomy, employ advanced algorithms like A* for efficient route planning, potential fields to deftly avoid underwater obstacles, and simultaneous localization and mapping (SLAM) for real-time mapping. These algorithms work together seamlessly, allowing the robot to chart optimal paths, steer clear of hazards, and create precise underwater maps as it explores the oceanic environment. This level of control and autonomy empowers the robot to carry out its mission autonomously, making it a reliable and efficient solution for tackling e-waste pollution in deep waters.

Now focus is on nurturing the intelligence of the deep-water robot. It involves training AI and machine learning models to enable the robot to recognize and classify e-waste items underwater. The implementation of deep learning algorithms further enhances its capabilities, allowing for real-time image analysis and intelligent decision-making based on what the robot sees. This AI-driven technology plays a vital role in ensuring that the robot efficiently identifies and categorizes e-waste items, even in challenging underwater conditions. It reduces the impact on non-waste items and contributes to precise and targeted collection efforts, aligning with the research's goal to combat e-waste pollution in oceanic environments.

After these steps, integrate of specialized robotic arms designed with high-torque motors and precise control systems. These arms are engineered for efficient collection of e-waste items from underwater environments. In addition, a watertight compartment is developed to deposit the collected e-waste. It's worth noting that the compartment features a perforated design, incorporating holes to alleviate pressure and allow water to flow, ensuring the safety and stability of the robot during the collection process. The bin design innovation it is totally comes with wholes enables effective e-waste collection but also reduces the pressure and water impact. The wholes can use to water flow.

Next focus on powering the robot effectively. To achieve this, incorporate high-capacity batteries to store power, ensuring sustained operations. In addition, harness renewable energy sources, including underwater turbines and solar panels, to prolong mission durations. This combination of power solutions ensures that the robot can continue its vital work for extended periods.

After all these steps, now focus on develop the robot. Gether everything and a fully functional robot. Then focus to testing part and validate both the hardware and software of this robot in carefully controlled underwater settings. This phase is crucial to ensure that the robot can perform tasks like underwater navigation, e-waste collection, and autonomous operations effectively. After that deploy the robot in real-world underwater environments to evaluate its actual performance. Collect valuable data and insights from these field tests, allowing to refine and optimize the robot's capabilities further. This iterative process ensures that the robot is fully prepared for its mission to combat e-waste pollution in the ocean.

So, now the robot can collect the e-waste In ocean sides.

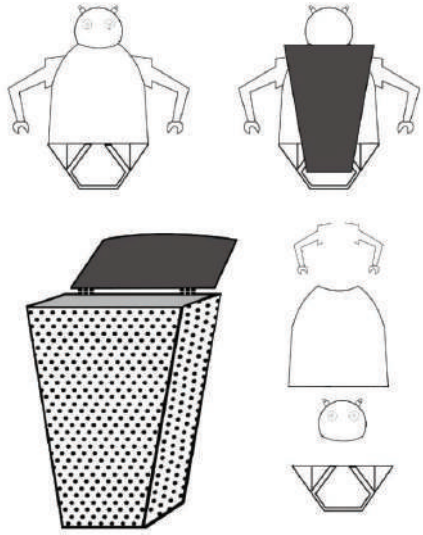

*Figure 1 The robot Sample sketch design*

In this picture the robot's sample sketch structure is here. in this structure there are several parts are there first one is **HEAD** this part has 2 eyes this are cameras. And the next one is **BODY or HULL** in this part include every circuit board and sensors. After that the **ARMS** this is used to get the e-waste and put it to the bin. Then the **BIN** this is used to collect the e-waste. Finally, the **STAND** this is used to landing the robot in underground of the ocean

## 4. Conclusions

The Deep-Water E-Waste Cleanup Robot is a cutting-edge innovation at the forefront of combatting e-waste pollution in our oceans, emphasizing environmental preservation and safety. This meticulously engineered solution possesses the potential to mitigate the severe threats posed by hazardous e-waste materials. Operating effectively in deep-water environments, it can dive as deep as 1000 meters, thanks to its underwater mobility, intelligent object recognition, and efficient collection capabilities.

Constructed using durable materials, such as titanium, the robot features a substantial bin for secure e-waste collection. Its advanced hardware incorporates AI processing and state-of-the-art algorithms, enabling real-time decision-making and precise navigation through complex underwater terrains.

The inclusion of specialized robotic arms and a watertight compartment designed for efficient water flow ensures effective e-waste collection. The robot's high-capacity batteries and renewable energy sources provide extended mission durations, amplifying its environmental impact.

After rigorous development and testing, this deep-water robot is now ready to tackle e-waste pollution in ocean environments, offering hope for a cleaner and healthier future for our oceans. This transformative solution highlights the role of technology and innovation in addressing pressing environmental challenges while protecting marine life and humanity.

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# CHURN PREDICTION FOR TELECOMMUNICATION INDUSTRY USING ARTIFICIAL INTELLIGENCE

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## Abstract

This research explores the application of artificial intelligence (AI) techniques for churn prediction in the telecommunications industry. The primary aim is to leverage AI algorithms to accurately forecast customer churn by analysing extensive customer data. Machine learning models, including Random Forest regression, decision trees, and XGBoost Regression are employed to create predictive models. These models undergo rigorous evaluation, offering insights into factors influencing churn. The research has significant implications for telecom companies, enabling proactive customer retention through targeted strategies, ultimately reducing churn rates and enhancing customer loyalty in a dynamic consumer landscape.

## Extended Abstract

### 1. Introduction

The telecommunications industry grapples with a persistent challenge: customer churn, leading to revenue loss and market share erosion. Artificial intelligence (AI) offers a promising solution for predictive churn analysis. This research delves into AI-based churn prediction tailored for the telecom sector, aiming to empower companies with proactive customer retention strategies. Our objective is to leverage AI algorithms for accurate churn forecasting.

By analysing extensive customer data, including demographics, call records, and service usage, we aim to identify crucial indicators and patterns associated with churn behaviour. Machine learning algorithms like logistic regression and decision trees will be employed to create predictive models. The models' performance will be rigorously evaluated using established metrics. Valuable insights will be derived, aiding companies in identifying at-risk customers and implementing targeted retention strategies.

This research promises to equip telecom companies with tools to reduce churn rates and enhance customer loyalty in an era of evolving consumer preferences.

## 2. Methodology

Exploratory Data Analysis Prior to constructing the decision tree algorithm, an important step in the research process was conducting Exploratory Data Analysis (EDA). EDA plays a vital role in decision tree algorithms as it provides valuable insights and prepares the data for effective modelling. The following steps were undertaken during EDA:

Dataset Overview: The structure, dimensions, and general statistics of the dataset were examined, including mean, median, and standard deviation. This initial exploration provided a comprehensive understanding of the data and identified any missing values or outliers.

Relationship Exploration: The relationship between the target variable (the variable to be predicted) and the input features was investigated. Visualizations such as scatter plots, histograms, and box plots were employed to identify potential patterns or correlations within the data.

### 1. Random Forest Regression

Random Forest Regression is a non-parametric method that does not rely on specific assumptions about the data distribution. It can handle different types of data, including skewed data and categorical variables (ordinal or non-ordinal).

#### 1.1 Data Preparation

The data preparation process involved evaluating the available data and selecting relevant variables for regression analysis. Certain fields, such as customer ID, latitude, longitude, and case order, were deemed irrelevant and excluded from consideration. Only meaningful variables were chosen to ensure accurate and insightful results. Categorical variables, including gender, internet service, and phone service, were converted into binary columns using dummy variable encoding.

#### 1.2 Model Creation

A Random Forest Regression model was developed using all available variables in the dataset. Additionally, a multiple Linear Regression model was created for comparison purposes. The models were evaluated based on their performances and outputs, with a focus on determining the importance of different predictor variables in the Random Forest model's decision-making process. The dependent variable was "Churn," while the remaining variables served as predictors.

### 1.3 The Classification Report

The classification report for the Random Forest model

| Precision | Recall | F1- score | Support | |
|---|---|---|---|---|
| Class_0 | 0.81 | 0.94 | 0.87 | 18 |
| Class_1 | 0.94 | 0.73 | 0.82 | 22 |
| Class_2 | 0.88 | 1.00 | 0.93 | 14 |
| Accuracy | | | 0.87 | 54 |

In the classification report of the random forest regression model, the following evaluation metrics are provided for each class: precision, recall, and F1-score. These metrics give us insights into the performance of the model for each class.

## 2. Decision Tree

This decision-making and branching process continues until the algorithm reaches the maximum depth of the tree or when further splits are no longer feasible, resulting in a terminal or leaf node.

Predictions can be made by considering the average values of the data points within a leaf node for numeric data. For categorical data, the predicted category assignment is determined based on the categories of the data points within the leaf nodes. During the testing phase, unknown data points are processed through the same decision tree structure. These data points traverse through all the checks and eventually land in different leaf nodes. By utilizing the values or categories of the points within the leaf node, predictions are made regarding the test data points.

### 2.1 Feature Importance

An interesting aspect of rule-based learning is the ability to visualize the importance of each feature in predicting the target variable. A chart was generated to illustrate the relative importance of the features in predicting the churn class. This provided valuable insights into which features had the most significant impact on the prediction outcome. By understanding feature importance, the underlying patterns and factors contributing to customer churn could be better comprehended.

### 2.3 Hyperparameter Tuning For Random Forest

Hyperparameter tuning plays a critical role in optimizing the performance of a machine learning model, specifically in the case of Random Forest. It involves selecting the most suitable hyperparameter values before the learning process begins. Failure to perform hyperparameter tuning can lead to errors and inaccurate results, as the model's loss function remains un minimized. The primary objective of hyperparameter tuning in Random Forest is to identify the optimal combination of hyperparameter values that maximize the model's performance, minimize the loss, and generate improved output. By carefully selecting the right hyperparameters, we can enhance the overall effectiveness and predictive capability of the Random Forest model, ensuring more reliable and accurate results.

### 2.4 Model Performance

The performance of the random forest regression model was evaluated using the following metrics:

1. Average Error: The average error of the model was calculated to be 3.6561 degrees. This indicates the average deviation between the predicted values and the actual values of the target variable.

2. Accuracy: The accuracy of the model was determined to be 93.83%. This metric represents the percentage of correctly predicted values out of the total number of instances in the dataset. The random forest regression model demonstrated promising results with an accuracy of 93.83%, indicating that it can effectively predict the target variable. Furthermore, the average error of 3.6561 degrees suggests that the model's predictions are, on average, within a reasonable range of the true values.

Compared to the baseline model, the random forest regression model showed an improvement of 0.50% in accuracy. This improvement highlights the effectiveness of the random forest algorithm in capturing complex relationships within the data and generating more accurate predictions.

### 2.5 The classification report

The classification report for the decision tree model

| | precision | recall | f1-score | support |
|---|---|---|---|---|
| class_0 | 0.79 | 0.92 | 0.85 | 12 |
| class_1 | 0.87 | 0.83 | 0.85 | 24 |
| class_2 | 0.94 | 0.89 | 0.91 | 18 |
| accuracy | | | 0.87 | 54 |

The support column represents the number of instances in each class. Overall, the decision tree model achieved an accuracy of 0.87, meaning it correctly classified 87% of the instances in the test data.

$$precision = \frac{TP}{TP + FP}$$

$$Recall = \frac{TP}{TP + FN}$$

$$F1 = \frac{2 * precision * Recall}{precision + recall}$$

$$Accuracy = \frac{TP + TN}{TP + FN + TN + FP}$$

$$Specificity = \frac{TN}{TN + FN}$$

### 2.6 Hyper parameter Tuning for Decision Tree

The accuracy of the model after hyperparameter tuning is 0.83 (83%). Comparing it to the accuracy reported earlier, it seems that there has been a slight decrease in accuracy after hyperparameter tuning.

## 3. XGBoost Regression

XGBoost, short for "Extreme Gradient Boosting," is a powerful and widely used machine learning algorithm known for its exceptional performance in various prediction tasks.

### 3.1 Data Pre-processing

Data pre-processing plays a crucial role in ensuring the quality and suitability of the dataset for machine learning tasks. In this research, the dataset was obtained from Kaggle, a reputable data repository website. It consists of 37 predictor variables that capture different aspects of customer usage patterns. The dataset comprises a total of 7,043 records, with 1,869 customers labeled as churners and 4,720 classified as non-churners. It is important to note that the dataset exhibits an imbalance, with churners representing approximately 26.5% of the total customer population.

### 3.2 Data Normalization:

After completing the data cleaning and transformation steps, the next important stage is data normalization. The rest of the features in dataset. That is scaled using RobustScaler and StandardScaler respectively from Sklearn library. RobustScaler from Sklearn uses the interquartile range and scales the features that are resistant to outliers.

$$S\,(xi) = xi - \frac{Q1(x)}{Q3(x) - Q1(x)}$$

$$S\,(xi) = xi - \frac{mean(x)}{stdev(x)}$$

rtile and Q3 is the 3rd quartile. Whereas Standard Scalar iance. The equation for StandardScaler is given as

$$S\,(xi) = xi - \frac{mean(x)}{stdev(x)}$$

$$S\,(xi) = xi - \frac{mean(x)}{stdev(x)}$$

### 3.3 Model Building

Prior to fitting the XGBoost model to our data, it is essential to appropriately prepare the feature set (X) and label set (y) and perform a train-test split.

The feature set (X) comprises the independent variables or attributes that will be utilized for prediction, while the label set (y) consists of the target variable that we aim to predict. It is crucial to ensure that the feature and label sets are correctly aligned.

Following the preparation of the X and y sets, we proceed with the train-test split. This widely adopted technique involves partitioning the dataset into two distinct subsets: the training set and the testing set. The training set serves as the foundation for training the XGBoost model. By exposing the model to the input features and their corresponding labels, it can effectively learn the underlying patterns and relationships within the data.

The Classification Report XGBoost

| | precision | recall | f1-score | support |
|---|---|---|---|---|
| Class_0 | 0.95 | 1.00 | 0.97 | 18 |
| Class_1 | 1.00 | 0.94 | 0.97 | 17 |
| Class_2 | 1.00 | 1.00 | 1.00 | 19 |
| Accuracy | | | 0.98 | 54 |

## 3. Result and Discussion

### 1. Random Forest Regression:

The Random Forest Regression model demonstrated remarkable predictive accuracy. The R-squared value of 0.9999932225 suggests that the model can accurately predict customer churn, and the low Mean Squared Error of 0.111799798 indicates that its predictions are very close to the actual values. In the classification report, the model showed strong performance for all three classes (Class 0, Class 1, and Class 2). It achieved high precision, recall, and F1-scores for each class, indicating its ability to correctly classify customers into their respective categories. The overall accuracy of 87% is promising, and the weighted- average F1-score of 0.87 suggests a balanced performance across all classes.

### 2. Decision Tree:

The Decision Tree model also demonstrated solid performance with an accuracy of 87%. It showed good precision, recall, and F1-scores for all three classes, highlighting its effectiveness in classifying customers into their respective categories. Notably, the model achieved high recall for Class 0 and Class 2, indicating that it correctly identified most instances for these classes. The weighted-average F1-score of 0.83 reflects a balanced performance across all classes.

### 3. XGBoost Regression:

The XGBoost Regression model outperformed the other models with an impressive accuracy of 98%. It demonstrated near-perfect precision, recall, and F1-scores for all three classes, indicating its exceptional ability to classify customers accurately. The model's overall accuracy of 98% suggests that it can effectively predict customer churn. The combination of data preprocessing, feature engineering, and the power of the XGBoost algorithm resulted in a highly accurate and reliable model.

In summary, all three models showed promising results, but the XGBoost Regression model stood out as the most accurate and reliable for predicting customer churn. The Decision Tree model also performed well, especially in terms of recall, while the Random Forest Regression model provided a good balance between precision and recall.

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# EVALUATION OF THE PERFORMANCE OF HIGH STRENGTH CONCRETE BY REPLACING RIVER SAND WITH MANUFACTURED SAND

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## Abstract

A huge amount of concrete is consumed by the by the construction industry. About 35% volume of concrete is comprised of sand. A good quality concrete is produced by careful mixing of cement, fine and coarse aggregates, water and admixtures as needed to obtain an optimum quality and economy. The fine aggregates or sand used is usually obtained from natural sources especially from river beds or river banks. Nowadays due to constant sand mining the natural sand is depleting at an alarming rate. Sand dragging from river beds have led to several environmental issues. This has led to a scarcity and significant increase in the cost of natural sand. So, there is an urgent need to find an alternative to river sand. The only long-term replacement for natural sand is manufactured sand.

So, this research aims to evaluate the performance of high strength concrete by replacing river sand with manufactured sand partially and fully. An attempt is made in this research by partially and fully replacing the natural sand with manufactured sand to study the characteristics of fresh and hardened Grade 60 concrete (M60) using mix designed prepared according to the American Concrete Institute (ACI) and also physical properties of materials and concrete were tested as per American society for Testing and Materials (ASTM) standards.

This study explores the utilization of manufactured sand as a viable alternative to natural sand in the production of High-Strength Concrete (HSC) with a focus on concrete strength up to M60 grade. Through comprehensive experimentation, it has been observed that the inclusion of manufactured sand positively impacts concrete strength, showcasing its effectiveness as a convenient substitute for fine aggregate. The incorporation of mineral and chemical admixtures further enhances the compressive strength of HSC. The replacement of natural sand with manufactured sand not only contributes to the conservation of natural resources but also promotes ecological balance. The physical properties of manufactured sand, including a well-graded particle size distribution, a fineness modulus value of 2.80, bulk density of 1937.33 kg/m3, specific gravity of 2.72, and water absorption value of 0.63, support its suitability for concrete applications, establishing it as a promising material for sustainable construction practices.

## Extended Abstract

### 1. Introduction

Concrete is a widely used construction material for various types of structures due to its structural stability and strength. All the materials required for producing such huge quantities of concrete come from the earth's crust. Thus, it depletes its resources every year creating ecological strain. On the other hand, human activities on the earth produce solid waste in considerable quantities including industrial wastes. The main cause of concern is the nonrenewable nature of natural sand and the corresponding increasing demand of construction industry, therefore looking for an alternative to river sand has become a necessity.

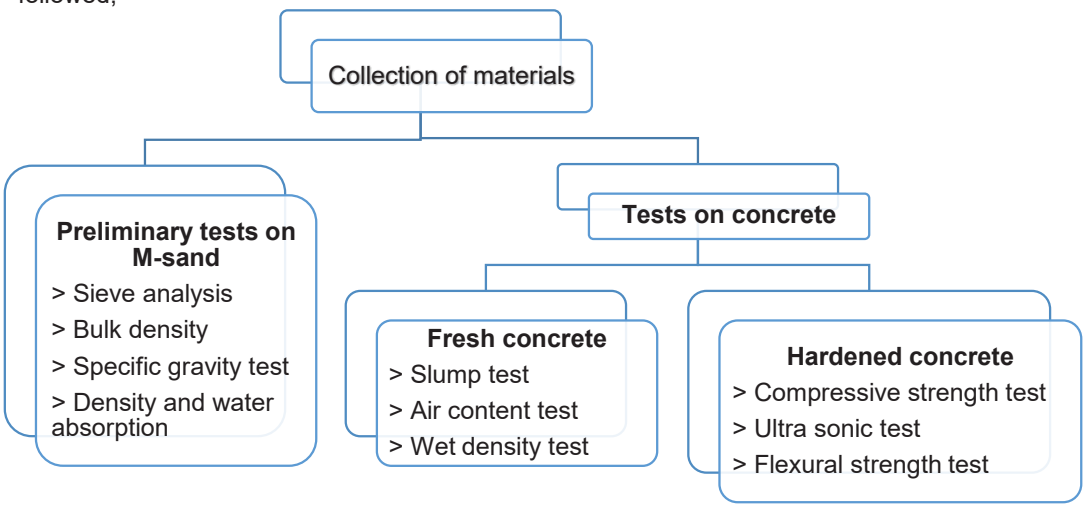
The cheapest and easiest alternative to natural sand is manufacturing sand by crushing rocks/stones in desired size and grade by suitable method. Sand produced by such means is known as manufactured/crusher/artificial sand. Thus, we have started using manufactured sand in all most all our concreting activities. However, the use of manufactured sand in a high strength concrete is still not gained any confidence. Research done by investigate the effect of M-Sand in structural concrete by replacing river sand and development high performance concrete and also compare the differences in properties of concrete containing river sand and M-sand.

High strength concrete helps (Limbachiya et al.) in building tall structures, important monuments, reduces the structural thickness. High strength concrete is more durable and hence it can be used for marine structures, nuclear reactor buildings and many such important Structures. This paper presents the results of experimental investigation of partial and full replacement of natural sand by manufactured sand. The main aim of the paper is to compare the compressive strength and workability of high strength concrete with manufactured and natural sand in varying proportions. In the present paper, the attempt is made to design mix for HSC of M60 grade concrete.

## 2. Methodology

The research methodology employed in this study is crucial for achieving the project's objectives, and it is structured into distinct sections to facilitate efficient handling. The primary focus of the methodology is on the evaluation of fine and coarse aggregates, integral components in concrete production. Fine aggregates underwent a series of tests, including sieve analysis to determine particle sizes, specific gravity tests to ascertain material density, water absorption tests to quantify water absorbed, and bulk density tests aiding in the selection of concrete mix proportions. Similarly, coarse aggregates were subjected to sieve analysis, specific gravity tests, water absorption tests, and bulk density tests for proportion selection in concrete mixtures. This research adopts a quantitative approach, employing a systematic and empirical investigation to gather data on the physical properties of fine and coarse aggregates. The chosen tests serve as instrumental tools in assessing the suitability of manufactured sand as a replacement for natural sand in high-strength concrete production. The structured methodology ensures a comprehensive analysis of the aggregates, laying the foundation for informed decisions in the development of sustainable and high-performance concrete.

To achieve the aim of the research project the methodology (Price and Hynes, 1996) is divided into parts so that it would be easy to handle, then the following procedures were followed,



- **Fine aggregates**
  - Sieve analysis test : To find the sizes of the particles
  - Specific gravity test : To find the density of materials
  - Water absorption test : To find amount of water absorbed
  - Bulk density test : For selecting proportions for concrete mixtures

- **Coarse aggregates**
  - Sieve analysis test : To find the sizes of the particles
  - Specific gravity test : To find the density of materials
  - Water absorption test : To find amount of water absorbed
  - Bulk density test : For selecting proportions for concrete mixtures

## 3. Results and Discussion

From the test results of particle size distribution test according to ASTM 136 standards it was found that M-sand has more fine particles and more coarse particles than natural sand and also only few parts of the graph satisfy boundary conditions according to the ASTM C33 standards.

These are graphically described below,

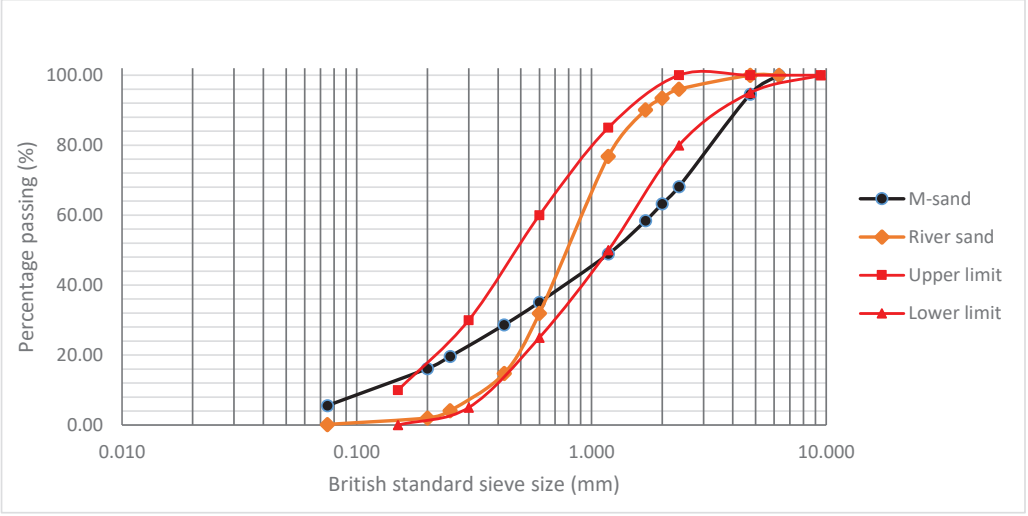



**Fig 01:** Comparison of M-sand with natural sand

The reason for the above conclusion is manufactured sand has higher clay and silt contents compared to natural sand and also it leads the higher water demand in concrete and also it was found that the fineness modulus of the M-sand is 2.8. Comparing with M-sand curve, River sand curve is slightly vertical so it is evident that river sand has more particles with same sizes but M-sand has particles which are evenly distributed.

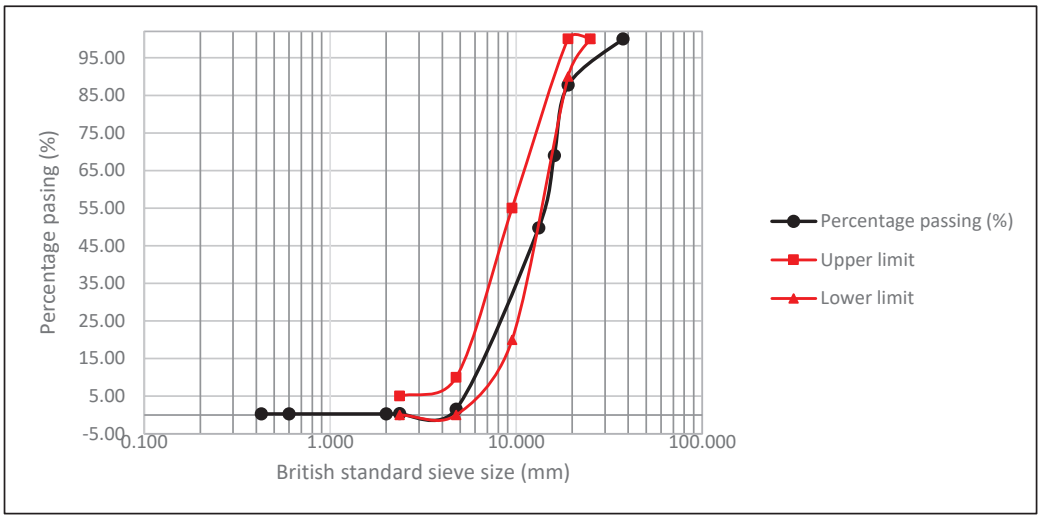



**Fig 02:** Particle size distribution curve for coarse aggregate

The above graph shows the particle size distribution curve of coarse aggregate with upper and lower limits. From the graph we can say that some parts of the graph are deviating from the limits. These limits are standard specifications of concrete aggregates. The maximum size of the aggregate that we used was 19 mm.

## 4. Conclusions

The manufactured sand is used in natural concrete all over the world. It gives good properties. The use of manufactured sand for HSC is the present need. It is observed that concrete strength is increased up to M60 grade from above experimentation. Therefore, it is effective and convenient alternative as fine aggregate. HSC concrete can be developed using manufactured sand supported that use of mineral and chemical admixture can improve the compressive strength of concrete.

The replacement of Natural sand with manufactured sand will help in conserving the natural resources of sand and maintain the ecological balance of the nature.

It can be concluded that manufactured sand has acceptable physical properties since following results obtained from all the results,

- Well graded article size distribution
- Most of the particle size distribution curve lies within the lower and upper limits
- 2.80 of fineness modulus value for manufactured sand compared to 2.70 in river sand
- Bulk Density value of 1937.33 kg/m3 compared to 1636.92 kg/m3 in river sand
- Specific gravity of 2.72 for manufactured sand compared to 2.63 for river sand
- 0.63 of water absorption value for manufactured sand compared to 0.38 in river sand

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# THE INVESTIGATION OF THE KEY DRIVERS FOR OFF-SITE CONSTRUCTION IN SRI LANKA

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## ABSTRACT

Off-site construction (OSC) has been recognised as an approach to transforming the construction sector from a labor-intensive to a modernised and green industry. Despite a number of advantages, the development of OSC remains at its infancy in Sri Lanka (SL) due to various interactive barriers. Some studies have been conducted to explore barriers to the adoption of the OSC. However, very few studies attempted to investigate the complex interrelationships among these barriers. The aim of the research was to investigate the present adaptability of OSC in SL. A qualitative research approach was followed to pursue the research aim.

First, critical barriers were identified through literature review and semi-structured interviews with various responders. Results indicate that specific attention should be paid to inadequate policies and regulations, a lack of knowledge and expertise, a dominant traditional project process and a low standardisation level. In order to facilitate the research, a qualitative approach was conducted through semi-structured interviews to collect the relevant data for analysis. For the analysis, eight interviews were considered where all questions were based onsite and off-site within them. The content analysis was done by using NVivo 12.

The research findings provide valuable information for policymakers on the overall structure amongst barriers. These results shed light on effectively developing measures to facilitate OSC adaption in the construction sector.

**Keywords:** Off-site construction, Barriers, Adaptability, Sri Lanka, Construction Industry

## 1 INTRODUCTION

Globalisation combined with growing infrastructure investments has contributed to the rapid growth of the international construction sector (Jang, Kwon, Ahn, Lee, & Park, 2019; Kang, Jin, Hyun, & Park, 2018; Ye, Lu, Flanagan, & Ye, 2017). In the current global context, the credit goes to OSC for its planning, design, manufacturing, transport, and assembly of manufactured components in a fast and time-saving on-site fastening process (Sanjeepan, 2018). According to Flanagan and Ye (2017), with its significant advantages of budget flexibility in prices, without inhibiting the standard or strength of the end product compared to conventional construction methods. The implementation of these techniques is seldom purchased in practice in the construction sector in SL (Sanjeepan, 2018). In the construction sector, there are several types of OSC methods (Lu, 2007). According to Blimas (2007), there are volumetric or modular structures insulated structural panels and pre-assembled elements**.** OSC techniques, including off-site pre-assembly, hybrid system, panel system, and modular building, prove to be among the most successful approaches in the construction industry to overcome the challenges (Kang, Jin, Hyun, & Park, 2018). OSC is defined as the manufacture and preassembly of components, elements, or modules at their final location before installation (Goodier & Gibb, 2007). OSC helps to move construction activities into a controlled environment, enables the workers to be coordinated in a manufacturing-like manner, allows for higher quality standards, increased productivity, and decreased waste, thus increasing the overall efficiency of the process (Nihar Nanyama, Sawhneyb, & Guptaa, 2017).

According to Yap (2012), with greater consistency, since the same product types are exactly the same, more quality control, especially with regard to compliance with standards, the OSC

process is streamlined, and systems can be easily measured and more accurately. There are initial costs, significant construction work costs, external costs, continuous funding, and capital investment (Musa, Mohammad, Yusof, & Ahmad, 2016). Some components must be assessed before choosing an OSC rather than an on-site construction (Velamati, 2012). According to Kamali and Hewage (2016), all preliminary cost savings were of pure preliminary items because of the less number testing at the sites, less amount of insurance required, no need for much quality management procedures at the site, less site waste management plans, the less amount of staff and welfare clearance, water, electricity, and furniture. Industry practitioners should investigate the more reliable OSC methods to avoid the current challenges due to a lack of knowledge on different OSC methods (Wasana, Sachie, & Fasna, 2019). Shortages of skilled workers and factory capacity to manufacture parts have hindered the usage (Zhai, Reed, & Mills, 2014). According to Uthpala and Ramachandra (2015), public attitudes are preferred by the general public to conventional constructions over the OSC. Transporting entirely manufactured houses or partially completed modules is complex, costly, and very difficult (Creswell, 2014).

### 1.1 Problem Statement

OSC can be considered as an innovation in construction (Samarasinghe, et al., 2017). According to Wasana et al. (2019), it is introduced to the industry with the aim of creating the potential evolution of most on-site works away from the construction site to a manufacturing facility. This will guarantee advanced quality as well as safer construction under controlled operational circumstances. Compare to conventional construction, OSC has several advantages and disadvantage also (Kamali & Hewage, 2016). According to Jayasena et al. (2016), more challenges and problems have been identified, which remain still within OSC.

Construction projects in SL often undergo different complications because of labour intensity and wet trade of the construction industry (Sanjeepan, 2018). According to Uthpala and Ramachandra (2015), to overcome the above-mentioned problems, OSC has been introduced. However, the Sri Lankan construction industry rarely practice OSC. Therefore, this paper emphasises identifying the existing practice of OSC and the barrier available in the industry to improve OSC usage. Therefore, there is a valid reason to carry out the research on above topic.

The paper clearly structured as follows; the discussion begins with the brief study of literature review of the concepts and developments of OSC and the necessity and benefits of OSC to the construction industry. As the next step, it explains about the methodological concern of the research process. The findings and analysis of collected data through data collection techniques is discussed as next step. Finally, conclusion recommendations were proposed to investigate present status of OSC and propose adaptability strategies of OSC in SL.

## 2 RESEARCH METHODOLOGY

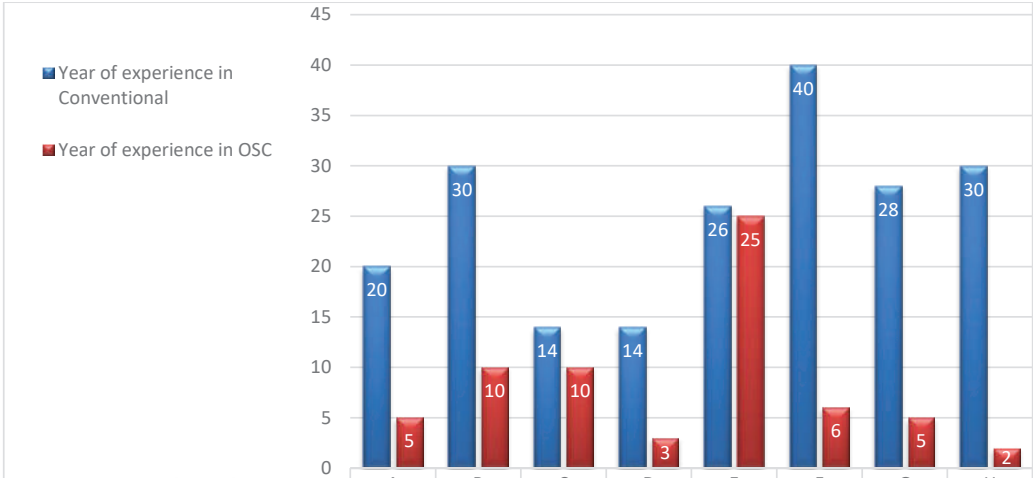
The research methodology is the process to follow to achieve the aim and objectives of the study. The research methodology was developed with the aim is to investigate the present status of OSC and propose adaptability strategies of OSC in SL. The research was directed to determine the significant barriers for off-site construction and possible solutions. The exploratory needs of research directed and a qualitative approach was undertaken further the research identified the practices on possible solutions in Sri Lankan context. As a result, the research needed to acquire in-depth information. Thus, considering such a nature, qualitative method approach was adopted to achieve the research's aim and objectives. Semi-Structured Interviews were adapted to do data collection. Hence, some determined questions were included in the guideline, and the construction industry is rapidly changing; thus, it cannot go through a structured interview. As a result, considering the above three types, the semi-structured interview was adapted as a research technique to generate the research. The collected data from semi-structured interviews were analysed through content analysis technique was used to facilitate content analysis of this research, NVivo 12 software was used.

# 3 RESEARCH FINDINGS AND ANALYSIS

## 3.1 Semi-structured interviews

Selected respondents were interviewed using a semi-structured interview guide. The interview guidance was structured in three (03) sections. The background information of the respondent is set out in section 01. Section 02 was structured to investigate the current level of OSC applicability in SL. Subsequently, the effectiveness of the OSC, the opinion on the OSC and the types of method are observed under section 03. Subsequently, the barriers to the adaptation of OSC in SL and the strategies to overcome barriers were explored.

## 3.2 Experience of Industry Practitioners on OSC




| Interview code | A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|---|
| Year of experience in Conventional | 20 | 30 | 14 | 14 | 26 | 40 | 28 | 30 |
| Year of experience in OSC | 5 | 10 | 10 | 3 | 25 | 6 | 5 | 2 |

Figure 3.1: Year of experience in OSC and conventional construction

Overall all responders are work with conventional construction rather than OSC. Rarely one or two respondents are work parallel with OSC and conventional construction. Mostly all of the respondents have more than five years' experience in OSC. So overall, mainly conventional construction method is higher effectiveness than OSC in SL. However, at the same time, OSC also is customary.

- **Purpose of OSC**

In traditional construction methods, works are executed consecutively. However, OSC allows works to proceed concurrently, which can shorten the construction schedule significantly (Hwang, Shan, & Looi, 2018). However, mostly all experts gave the same views as shorten the time frame to achieve the time target. *It is to improve quality, doing in off-site and factory will increase the quality and improvement on time is also another reason (replication). Some productions are done using sophisticated technology.* Therefore, it highlights that off-site modularised chosen for the purpose is cut down on time, cost, people, process, product and less environmental impact. So, it is better to do in the OSC method, and people are moving to OSC because of labour fair also. At the same time, this kind of reasons explains the purposes of choosing OSC in SL.

- **Types of OSC use in SL**

It seems to be that there are various types of OSC are used in SL. Like low modular cost housing schemes, precast components housing unit, warehouses, petrel shape and low

modular cost housing schemes. However, rarely did the entire building as OSC method. Mostly did part of the components as OSC method. So low modular cost housing schemes, precast components housing unit, warehouses, volumetric construction and petrel shape are more effectiveness OSC types in SL.

- **Level of OSC practices**

*Simultaneously in SL mostly everything done in conventional method only part of the construction done in OSC in SL*. However, basically everything conventional method like slabs, beam and lintel. All of the time respondents said the percentage of OSC is depend on project, design, location and type of the OSC. However, in SL construction industry rarely use OSC method with a low percentage. At the same time, the construction industry has effectiveness in OSC method with the low comfort level.

- **Requirements of Clients**

100% of design is not possible to finish in the construction stage with respect to the clients' needs. However, in the design stage, it can be possible; however, it also depends on client knowledge about OSC. In SL construction industry rarely have effectiveness to finish OSC with client need.

- **Variations during OSC**

*Variations which happen during constructions, then those variations should accommodate onsite variations*. OSC has fewer variations than a conventional building. At the same time, it can be handled as the construction is on site. So, with responder comments variation is lower than a conventional building.

- **Cost/ time overrun in OSC**

OSC Cost/ time overrun discussed with two various stages, such as design stage and construction stage. Cost/time overrun minimum happens in the design stage; however, it can reduce by value engineering methods. So, if there is cost/time overrun, they have proper overcome methods. So, in SL is effective in OSC. Cost/time overrun happens in the construction stage also it can reduce by value engineering methods, proper planning of work, proper competences, proper skill people and time to maintain the cost.

- **Payments in the OSC method**

The payment interval is as usual, monthly and there is no much difference, and the client can concentrate on his cash flow at the beginning of the project by doing; therefore, the client can minimise the difficulty. It can also have a chance to get an effective interval payment method in the OSC method in SL.

- **Feasibility**

OSC feasibility is clarified with physical, commercial, technical, environmental and legal. *In SL are not acceptable in space feasibility for OSC, highly feasible since space is critical at sites and dedicated factories are needed*. Better space, proper land, and required other equipment will come, which will make physically good feasible in SL. So, in SL physically less effective to OSC in Sri Lanka.in commercial, *generally rather than traditional building. Mainly we have a minimum cost overrun. We know what we are expending major part of the building manufacturing within the control environment. We do have the best discussion from the environmental when we are doing erection. We have to focus certain history in modular construction, and we can gain more certainty to happen random copy from the modular construction".*

Commercially feasible is good for OSC in SL rather than conventional construction. So commercially good effective to OCS in SL in Sri Lanka. At the same time could to do with present feasible of technology, want to adapt with present global technology. So technologically less effective with OSC in SL. Overall environmentally minimum impact in wastage however during the construction more chance to happen accident. So, want to take precaution to protect the environment. It is always advisable to protect people and site from accidents. Then want to do pre-planning for doing the work without disturbing others; so environmentally sound effective with OSC in SL. Legally, do not have any issues. However, during the construction, do not involve other problems like community problem, neighbour problem, authority problem approval, and all them. Then follow the legal instructions. Therefore, OSC is legally good effective in SL.

- **Assembling**

Transport and machinery are the main encountered issue in OSC assembling then wrong measurements will also become difficult in assembling. However at the same time responder gave precautions to avoid this kind of situation like reduce the size of components for transportation, follow the drawing and have to do the shop drawing, then recheck with the site, then get the quality control engineer, everything wants to test and review then only want to do it, want to do research and confirm our details at the site, start the work with the details and want to follow Proper manuals and supervision and instructions to overcome these constraints during assembling. Furthermore, transportation is not in good condition in SL but have manageable things.

- **Integration of materials/ facilities in manufacturing**

In SL, this is not too effective because of lack of experience, lack of accurate details with materials/ facilities, and then want to make sure they gave specifications and drawings. So, this kind of thing degrees effectiveness of OSC in SL.

### 3.3 Applicability of a Complete Off-site Modularised in SL

There are equally get good and bad comments to this. Because some of the responders said well because of the benefits like improving quality, Improvement on time and labour fairness, simultaneously, some responders said they could not accept the revision or the changes because they already keep on doing with the convention construction method. It also wants repetitive similarity, Pre-determination of technology, early approvals, pre-planned works, design capability and production erecting capacity, and safety. Then it not feasible to SL; people do not like to do with this construction method. So, there is not an accurate opinion about OSC.

- **Satisfaction of OSC**

The client satisfies OSC regarding early completion, quality and safety, environment and early construction, early investment return, and the working space is limited and delivers a quality product on time. For this kind of reason, it is liked OSC by clients. Simultaneously, some of the responders said client dissatisfaction due to the client mostly familiar with conventional construction. So, they cannot find an accurate opinion about OSC with their satisfaction.

- **Stability of integration**

Integration stability depends on design and supervision and maintaining the quality. However, at the same time, responder IG said about fittings problem, like still in SL do not have to combine different material, combining services to other building services, combining electrical system. So, People in SL have a good and bad opinion about OSC's stability and integration.

- **Durability of building**

OSC is good in durability because of script quality control systems, quality control is maintained and ensured, and then it was done in a console environment. Then it depends on design, method and material of use and quality. At the same time connections then plumbing and electrical connections, waterproofing, joint seal and crack control are some issues in the durability of OSC. So, People in SL equally have a good and bad opinion about OSC durability.

- **Maintenance for OSC**

Mostly the same as a conventional building. However, connections have to be adequately maintained and painting regularly. So, most of them having a positive opinion about OSC maintenance in SL.

- **Potential of OSC for the need of clients**

Almost fulfilled client requirements; however, not 100%. Because proper work is almost full fill client need. Then in SL, clients do not consider time; therefore, they do not concentrate on OSC. They only focus on cost; therefore, that is rarely full fill client need. However, mostly overall responder's opinion about the full fill level of client need is an acceptable level.

### 3.4 The Barriers Affecting the Adaptation OSC Method and possible solution for barriers in Sri Lankan Construction Industry

Affecting barriers to adaptation of the OSC method in the Sri Lankan construction industry have been analysed through a code-based content analysis. In order to capture the opinions on the barriers, interview guideline section 3 was addressed to the respondents. Subsequently, all responses were analysed using NVivo 12 software to generate the coding structure. According to the view, the only barriers were categories under several themes as shown in Figure 4.2. In such content references, the number of times the respondent referred to the respective barrier is indicated, in addition to the file section, the number of respondents referred to the respective barrier. As a result, twelve barriers were analysed using the NVivo 12 software shown in Figure 4.2.

Codes

| Name | Files | Referenc |
|---|---|---|
| Barriers | 0 | 0 |
| Lacking social climate & acceptance | 3 | 3 |
| Quality problems | 3 | 3 |
| Poor aesthetic performance | 5 | 5 |
| Ineffective logistics | 6 | 6 |
| Complicated management | 6 | 6 |
| Inappropriate business model | 6 | 6 |
| Limited market demand | 6 | 6 |
| Poor manufacturing capacity | 6 | 6 |
| Dominated traditional project process | 7 | 7 |
| Low standardization | 7 | 7 |
| Lacking knowledge and expertise | 7 | 7 |
| Inadequate policies and regulations | 8 | 10 |

Figure 3.2: Summary of the barriers of OSC

## 4 CONCLUSIONS

The OSC was identified as one of the modern construction methods. However, as a low-middle-income country, Sri Lanka should also be prepared to adapt the OSC method in the construction industry. In this context, despite existing OSC studies in different contexts, it was necessary to investigate the barriers associated with the adaptation of OSC in the Sri Lankan construction industry. The scope of this research was therefore narrowed to identify potential barriers and to develop appropriate strategies for OSC adaptation. Research objectives have been formulated in order to pursue this objective. In this context, a conclusion has been drawn from each objective as follows: The first objective of this study has been achieved through the literature review of this research. The findings of the chapter present OSC concepts for the global construction industry and OSC types for the construction industry. In addition, the literature review identified the necessity and outcome/effects of the use of OSC. The identification of the overall necessity and benefits of OSC to the construction industry has therefore resulted in the achievement of Objective 02. They have ensured that the current OSC projects are significantly lower in Sri Lanka. In addition, it also indicates that existing barriers need to be identified. Objective 03 was achieved on this basis. Several other barriers have also been identified. As a result, Objective 04 has been achieved. The fifth objective focuses on possible solutions to factors affecting the adaptation of the OSC method in the Sri Lankan construction industry. In addition, the solutions depend on the respondent's experience with the OSC.

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AWS Certified Solutions Architect, MCS(SL), ACPM(SL), MSLAAS, BIT (UOM), MSc in IT (SLIIT), MBA (SEUSL), LL.B (OUSL)

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In charge Head-School of Computing cum HND IT Coordinator (Kandy BCAS)

**22. Mr. Ganesaratnam Arunath**
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**23. Ms. S. M. S. Ayanthini Senarathne**
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Lecturer – IT - Kandy Campus, School of Computing, British College of Applied Studies

**24. Mr. Isuru De Alwis**
Lecturer in IT – Edith Crown University, Australia
BSc (Hons) in Information Technology – SLIIT, Master of Information Technology – University of Colombo School of Computing

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BSc in ICT – Rajarata University of Sri Lanka, Master of Information Technology – University of Colombo School of Computing

**26. Mr. Indika Priyadarshana**
Head – Systems and ICT, University of Vocational Technology, Sri Lanka
Bachelor of Information Technology – University of Colombo, School of Computing, Master of Information Technology - University of Colombo, School of Computing

**27. Mr. Minura Ahangama**
Head – School of Law
Attorney-at-Law, LLB (Hons) UoL, LLM (Merit) UWL

**28. Mr. Suresh Pathmanathan**
Head & Coordinator - Hotel Management cum Executive – Enrollments - School of Hotel Management & Tourism
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**29. Mr. Chenthuran Subramaniam**
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**30. Mr. M. Amila Makavita**
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**31. Ms K. Gayathri Mohandiramge**
Visiting Lecturer - School of Hotel Management & Tourism
Bachelor of Arts in English, French and translation (UOK)

**32. Chef Kalpa Perera**
Dip. In Tourism and Hospitality Management (Sri Lanka Institute of Tourism and Hospitality Management), Masters in Business Administration and Management General (MBA) - Australian Institute of Business, Australia

**33. Chef Piyadasa Gam Laddalage**
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Dip. In Cookery - Hotel School, Colombo 13

**34. Mr. K. A. D. Suresh Athukorala**
Visiting Lecturer, School of Hotel Management & Tourism
Cer.. In Hotel Housekeeping at Ceylon Hotel School, Kurunegala, HND in Hospitality Mgt. (College of Tourism and Hotel Management, Nicosia, Cyprus), Bachelor of Arts in Hospitality Management (College of Tourism and Hotel Management, Nicosia, Cyprus)

**35. Mr. Thilaka Siri Wijesundara**
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**36. Chef Randika Pramodh**
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**37. Chef Fazeel Kudhoos**
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**38. Ms. Kasthuri Kanagarajh**
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**39. Ms. Sulochana Ragunathan**
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School of Construction and Built Environment

**41. Eng. S.M. Pubudu Premasiri**
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**42. Eng. Tharindu Ranawaka**
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**43. Eng. A A Hafeel Ahamed**
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BSc Eng (Hons), MSc( Struc Eng), MBA

**44. Eng. M S M Uzair**
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**45. Eng. M. Senthooran**
Geotechnical E.I.T, Stantec consulting ltd., Canada.
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BSc (Hons) QS, MRICS, MAIQS, CQS

**47. Eng. Kamalaseelan Kajeenthan**
Coordinator/ Lecturer, BCAS Jaffna Campus
B.Sc.Eng .(Hons), MSc StructE (R), MBA, AEng, AMIE(SL), AMSSE(SL), UACSE(USA), GREEN SL®AccP(SL), IAMBS(SL)

**48. Eng. Dilsath Azeez**
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**50. Ms. Shashikala Kularatne**
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**51. Thafani Rasheed**
MBA in Finance (University of Colombo), BBA (Hons) in Finance (First Class, Gold Medalist) CAB – II of CASL

**52. Dr. Ramziya Bagam**
Master of Business Administration (MBA), (Special in Finance), Member of Certified Management Accountants of Sri Lanka (ICMA – Sri Lanka Bachelor of Management Studies (Hons) (Special in Management Science), Passed with second class upper division

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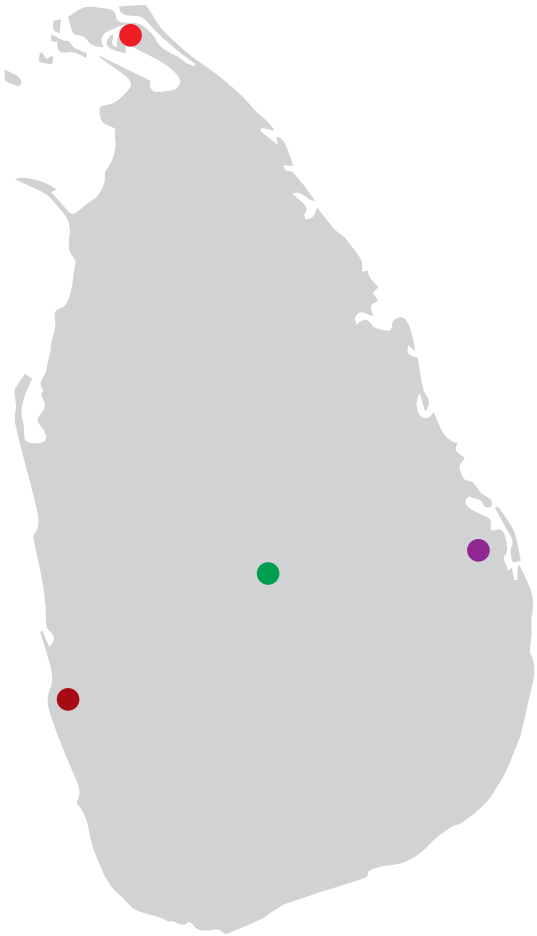

## SCHOOL OF COMPUTING

- International Foundation in Information Technology
- BTEC HND in Computing
  - Network Engineering
  - Software Engineering
  - Applications Development
- BSc (Hons) in Computer Systems & Networks
- BSc (Hons) in Cyber Security Management
- BSc (Hons) in Software Engineering

## SCHOOL OF BUSINESS

- Diploma in Business Management
- BTEC HND in Business Management
  - Marketing
  - HR Management
  - Accounting & Finance
- BSc (Hons) in Business Management
- BSc (Hons) in Accountancy & Finance
- Postgraduate Diploma Level 7
- Global MBA
- MSc in Project Management

## SCHOOL OF HOTEL MANAGEMENT AND TOURISM

- Diploma in Hotel & Tourism Management

## SCHOOL OF HEALTH AND SCIENCES

- International Foundation in Sciences
- BTEC HND in Applied Science (Biology)
- BSc (Hons) in Biomedical Sciences
- BSc (Hons) in Nursing
- Diploma in Health & Caregiving

## SCHOOL OF CONSTRUCTION AND BUILT ENVIRONMENT

- CCDT (Computerized Construction Design & Technology)
- BTEC HND in Civil Engineering
- BTEC HND in Quantity Surveying

## SCHOOL OF LAW

- LLB (Hons)

## SCHOOL OF LANGUAGES AND EDUCATION

- Diploma in English
- Certificate in English
- IELTS
- Diploma in Teaching (Primary)

## Notes

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**24** YEARS OF TRUST & EXCELLENCE IN HIGHER EDUCATION

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- Computing • Software Engineering • Computer Networks • Cyber Security
- Biomedical Science • Nursing • MBBS / MD (Overseas)
- Business Management • Marketing • H R M
- Construction Project Management • Quantity Surveying
- Civil Engineering
- Legal Studies

SCHOOL OF COMPUTING

SCHOOL OF HOSPITALITY AND TOURISM MANAGEMENT

SCHOOL OF BUSINESS

SCHOOL OF HEALTH AND SCIENCES

SCHOOL OF CONSTRUCTION AND BUILT ENVIRONMENT

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