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*“Embracing Change &
Transformation -
Breakthrough Innovation &
Creativity”*

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Symposium Proceedings



International College of Business and Technology - Sri Lanka



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Sri Lanka

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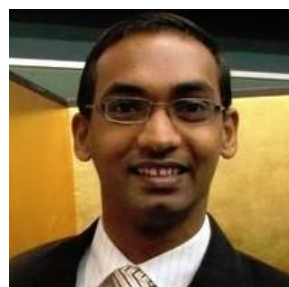
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Message from the Conference Chair

Dr. Sampath Kannangara

Executive Dean & CEO – International College of Business and Technology

It is a great privilege to Chair the Annual International Research Symposium of ICBT, ‘AIRS’ 2022’ to be held on 16th February 2023 at 9.00AM Sri Lanka Time. This is the fifth international research symposium organized by the International College of Business and Technology. This will continue to move forward in the research arena under the digital ISSN:2961-502X.



The theme for this year is “Embracing change and Transformation-Breakthrough Innovation and Creativity” which has opened up in to a multidisciplinary approach introducing a new area, Project Management to supplement the existing areas, Business Management, Information Technology, Health Science, Social Science, Engineering, Construction. This year the review panel consists of 33 international and local reviewers.

This research theme is a timely choice where the whole world is recovering from the unprecedented threat posed by the Covid-19. The post Covid-19 context poses many challenges since it had immensely affected our day-to-day living. Embracing change and transformation is needed to live with this new normal where innovation and creativity plays a major role. In the words of Theodore Levitt a renowned economist, “Creativity is thinking up new things. Innovation is doing new things”. The essence of this elucidates that these two components are inter-related. Transformation does not spur up as an isolated incident but as a consequence of creativity and innovation. This conference is not only going to add value but also cater towards a discussion where a paradigm shift has occurred post Covid-19 world.

I congratulate the organizing team for setting up the momentum to discuss this intellectual scholarship.

Message from the Editor-in-Chief

Dr. Kalum Kathriarachchi

Head of Department of Engineering and Construction

International College of Business and Technology

Dear Colleagues,

Welcome to the Proceedings of the 5th ICBT Annual International Research Symposium- AIRS'22 “Embracing change and transformation – Breakthrough Innovation & Creativity”.

First, I would like to express my gratitude to authors, reviewers and participants of 5th AIRS. Secondly, I would like to express my deepest appreciation to the authors whose technical contributions are presented in these proceedings. It is because of their excellent contributions and hard work that we have been able to prepare these proceedings.



Education without innovative research and development is meaningless for the community. This is more so when we are intertwined globally and contribution to global knowledge is the call of the day. I feel highly motivated by the positive response from contributors and like-minded educational fraternities exhibiting their deep interest in bringing this 5th ICBT Annual International Research Symposium.

AIRS endeavours to provide a forum for academicians, researchers and practitioners who are fascinated in the discussion of data driven innovation and are keen to promote, share and publish relevant high-quality research in the domains of Engineering, Health Science, Information Technology, Project Management, Business Management and Social Science. Thus, AIRS aims to promote the data driven innovations in various fields and provides assistance in decision making in relevant areas.

On behalf of the editorial board, I am very obliged to our track chairs/ co-chairs for their great efforts in reviewing the papers in their tracks and organizing to assign other volunteer reviewers, the conference technical program committee members, and the designated reviewers.

I would like to hear from you as well as your valuable suggestions on improving our symposium AIRS further. I sincerely extend my thanks to contributors, editorial board members and looking forward for continuous support in future.

I look forward to an exciting day of insightful presentations, discussions, and sharing of technical ideas with colleagues from around the world. I thank you for attending the conference and I hope that you enjoy your visit to conference AIRS.

Profound Regards,

Editor-in-Chief

Dr. Kalum Kathriarachchi

KEYNOTE SPEAKERS

Prof. Sheldon Hanton

Pro Vice Chancellor (Research & Innovation) Cardiff Metropolitan University, UK

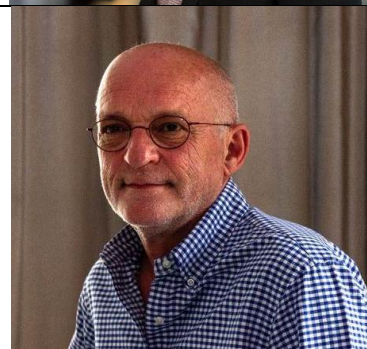
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Prof. Maurits Wymans

Programme Director – University College Leuven - Limburg

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Prof. Anura Jayasooriya

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From Creative Ideas to Tangible Outcomes: A desperate need for the struggling nation



Prof. Maros Finka

Slovak University of Technology in Bratislava

PED - Innovations synergy facing energy crisis and transformation



Ms. Karen Giles

Associate Head of School (CPD and International Nursing) /Principal Lecturer - University of Sunderland

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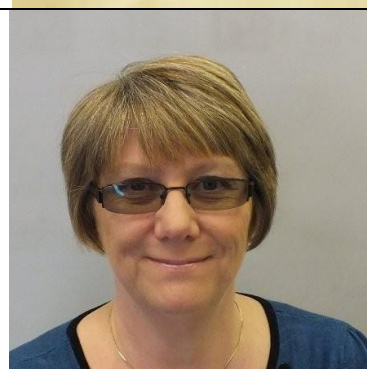


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Abstract

Visual Merchandising has created changes of the business industries and the LuvEsence store can be identified as a company which shows the visual merchandising in a proper manner. Due to the lack of empirical studies on this context, the purpose of this study was to investigate the impact of visual merchandising elements on consumer attention in LuvEsence, a beauty stores in Sri Lanka. 384 customers were selected as the sample of the study and the quantitative data collected through a self-administrated questionnaire. Data was analyzed based on multiple linear regression analysis. The results indicate that there are significant influences of Color and Lighting, Window Display and Interior Design on Consumer Attention, to use LuvEsence products and a critical influence of Store Layout on Consumer Attention. Findings suggested that it is needed to enhance the store layout of the LuvEsence store.

Key Words: Color and Lighting, Consumer Attention, Interior Design, Store Layout, Window Display.

Introduction

The planning, creating, and presenting products in order to display their characteristics and advantages are known as visual merchandising. Its objective is to attract and encourage customers to make a purchase (Keenan, 2021). To show products in an attractive and eye-catching way to potential customers, visual merchandising is used. It presents the products in a way that will turn window shoppers into prospects and eventually consumers by setting the context of the goods in an aesthetically pleasing manner. This emerging art can be used by a creative and talented retailer to revitalize his establishment (Jain, Sharma and Narwal, 2012). Visual merchandising is important because, it improved customer experiences and increased sales. As a result, retailing is interested in the activity of visual merchandising. Retailers are implementing a variety of unique differentiating strategies and approaches in their operations to stay in the market and gain a competitive advantage over the competition (Kerfoot, Davies and Ward, 2003). Visual merchandising is one of those advantageous tactics that are regarded as a key factor in a retail store's success. Both the interior and the outside are thought to significantly influence consumers' purchasing decisions. This method, which involves creating attraction and exhibiting things appropriately, aids in selling the correct kind of product to the right kind of buyer (Wanninayake and Randiwela, 2007). According to the (Pegler, 2011), by visually presenting the product to customers, visual merchandising affects their psychological behavior.

The primary reason behind conducting this research is to analyze the influence that visual merchandising and its elements on consumer attention in LuvEsence. The LuvEsence is a beauty store that is dedicated to bringing cruelty-free, all-natural and sustainably sourced

products made with Luv which located in Colombo. The LuvEsence have to use visual merchandising to display their products in a proper manner to gain the attention of the consumers and it is an important factor to this store. But there is a lack of research articles regarding the impact of visual merchandising on consumer attention in LuvEsence store. Most of the previous researches are based on identifying the main components of visual merchandising strategies influencing the consumer behavior (Mehta and Chugan, 2015; Preira *et al.*, 2010; Madhavi and Leelavati, 2013) impulse buying behavior (L.Bhatti and Latif, 2013), store choice behavior (Wanninayake and Randiwela, 2007). Because of that, there is a lack of empirical studies which have focused on the recognized relationship between the visual merchandising and the consumer attention.

An attempt was made to achieve the following research objectives.

Research objectives

1. To investigate the impact of Color and lighting of the LuvEsence store on Consumer Attention.
2. To investigate the impact of Store Layout of the LuvEsence store on Consumer Attention.
3. To investigate the impact of Window Display of the LuvEsence store on Consumer Attention.
4. To investigate the impact of Interior Design of the LuvEsence store on Consumer Attention.
5. To investigate the level of Consumer Attention towards the LuvEsence store.

Methodology

For this study, quantitative data was collected through a survey based on a questionnaire which was self-developed to suite the nature and objective of the study. The target population for this research is female consumers those who are living in Colombo district - 1,262,000 (Statistics, 2022) and according to this population 384 respondents were selected as a sample of the study. Sample calculated through the Morgan table under the 95% confidence level. Due to the unavailability of specific sampling framework, convenience sampling technique has implemented. A questionnaire was chosen as the data collection tool for this study. The questionnaire has been developed Likert scale of 1 to 5 starting from strongly disagree (1) to strongly agree (5) as well as it include some multiple-choice questions. The purpose of the study was to investigate and evaluate how visual merchandising elements including store layout, window display, color and lighting, and interior design of the LuvEsence store influence consumer attention.

Conceptual Framework

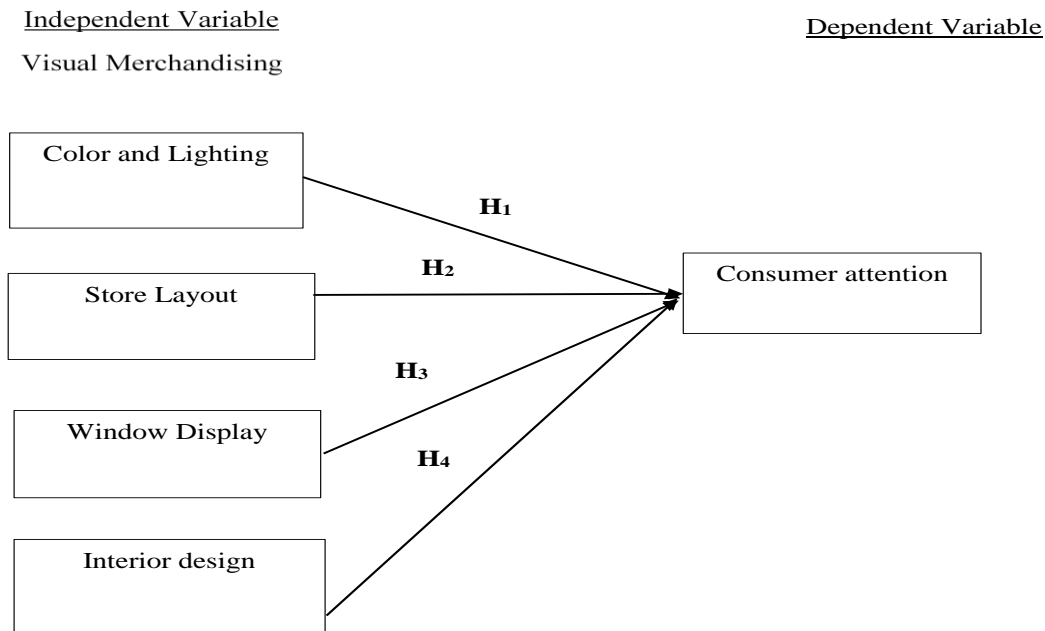


Figure 1 Conceptual Framework

Source: Developed by researcher

Research Hypothesis

H₁: There is a significant impact of Color and Lighting of the LuvEsence store on Consumer Attention.

H₂: There is a significant impact of Store Layout of the LuvEsence store on Consumer Attention.

H₃: There is a significant impact of Window Display of the LuvEsence store on Consumer Attention.

H₄: There is a significant impact of Interior Design of the LuvEsence store on Consumer Attention.

Results

Descriptive Statistics

Table 01: Descriptive Statistics

	Mean	Std. Deviation
CL	4.6859	.55402
WD	4.5564	.53660
ID	4.6936	.58639
SL	4.0299	.60131
CA	4.6994	.54298

Source: Analyzed statistical output from field survey

Multiple Linear Regression Analysis

Table 2: Coefficients

Model	B	Std. Error	P-Value	Collinearity Statistics	
				Tolerance	VIF
Constant	.422	.136	.002		
CL	.154	.043	.000	.300	3.331
WD	.262	.042	.000	.329	3.039
ID	.490	.038	.000	.334	2.994
SL	.015	.022	.489	.964	1.038

Source: Analyzed statistical output from field survey

$$CA = 0.422 + 0.154CL + 0.262WD + 0.490ID + 0.015SL + \varepsilon$$

Table 3: Model Summary

Figure	Value
R Square	0.780
Adjusted R Square	0.777
Std. Error of the Estimate	0.25626
Durbin Watson	2.053

Source: Analyzed statistical output from field survey

Table 4: ANOVA Table

Model	Sum of Squares	df	Mean Square	F-value	P-Value
Regression	89.405	4	22.351	340.368	0.000
Residual	25.282	379	.066		
Total	114.687	383			

Source: Analyzed statistical output from field survey

Discussion

Above table 01 represents Descriptive Statistics, consumer attention related mean value is 4.69. Therefore, the level of consumer attraction is available at an almost agreed level. As per the results illustrating through the table 02, the consumer attention will be equal to 0.422, when visual merchandising elements are equal to zero levels. When the color and lighting increase from average one unit while window display, interior design and store layout of visual merchandising elements equal to zero, the consumer attention will increase by 0.154. Further, if it is window display, interior design and store layout of visual merchandising elements the average change of the consumer attention will equal to 0.262, 0.490 and 0.015 respectively. Furthermore, the R square value of the model is illustrating that, 78% of the consumer attention is collectively represented the color and lighting, window display, interior design and store layout. According to the table 03, P-value of the model is 0.000. The model is significant at 95% of significant level and the null hypotheses can be rejected ($0.000 < 0.05$). According to that, the researcher shows, Higher F-values supported to reject the null

hypothesis and accept the four hypotheses of the study exists a low degree of correlation between the one variable. Out of the elements, interior design has created the salient impact. Window displays have a positive correlation with impulse buying behavior, and overall, visual merchandising has a significant impact on consumer buying behavior, according to results revalidating the findings of earlier studies (Kim, 2013);(Bashar and Ahmad, 2012) that visual merchandising is a very important tool and has an effect on impulse buying behavior. The results of this study confirmed earlier findings that offering customers distinctive window displays is the only way for merchants to maintain consumers' attention. Window displays have a favorable, significant impact on consumer attention (Mehta and Chugan, 2013). According to this study's findings, color and lighting have a significant and favorable impact on consumer attention, which is similar to those of (Aspfors, 2010), who found that lighting is essential to capture customers' attention and nudge them toward making a purchase. This research also found that color and lighting help to draw customers into stores (Jerry C. Peter, 2004);(Babin, Hardesty and Suter, 2003). Lastly, the store's layout needs to be well-organized with a nice interior because this encourages customers to stay longer. The layout must be such that a customer walking into the store may easily find what he needs (Ebster and Garaus, 2011). The findings of the present study are supporting to these findings and it has emphasized that the visual merchandising can be impacted to the consumer attention.

Conclusion and Recommendation

The study was aimed to identify the impact of visual merchandising elements on consumer attention in LuvEsence and this study concludes that visual merchandising has an impact on consumer attention. Color and lighting, store layout, window display and interior design all play major roles in attracting customers to a store. Multiple linear regression implemented to achieve it and the findings suggested that, color and lighting, window display and interior design have a significant effect on the consumer attention while the store layout of the LuvEsence has critical influence on consumer attention. It reveals that if the store layout has not been planned out and consumer is not able to figure out how to roam inside the store and effect on consumer attention and experience. Thus, the researcher suggests that LuvEsence store can redesign the passage way helps to avoid in-store traffic jams by enhancing the space and organization needed to implement different strategies regarding store layout. Additionally, for store managers to enhance sales, attracting customers' attention and consideration is important.

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**FACTORS INFLUENCING SUCCESSFUL IMPLEMENTATION OF
SUSTAINABLE PACKAGING
(STUDY ON YOGHURT PACKAGING IN SRI LANKA-WESTERN PROVINCE)**

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Abstract

Every single live form is impacted by massive amount of plastic generated through various human activities. Major portion of plastic wastage, represent by packaging materials and out of that 60% represent by the food packaging which includes dairy products as well. This suggests that sustainable packaging is urgently needed to protect the environment. There is an emerging market segment for sustainable products and organizations are now creating strategies for attracting this segment while achieving corporate environmental goals. The aim of the research is to understand the factors impacting the successful implementation of sustainable packaging solution (SPS) on the dairy products and mainly focusing on yoghurt as there is a deficit of data relating Sri Lankan context. Data from an online survey was used to test several hypotheses built on extensive literature review. To achieve research objective, survey data was analyzed using descriptive statistics, correlation, and regression. Results indicated that, there were a significant relationship and an impact with consumer awareness, user experience, regulatory framework to successful implementation of SPS. User experience showed the highest impact. Results revealed that, there is a significant work to be done to increase awareness on sustainable packaging.

Key Words: Consumer Awareness, Product Cost, Regulatory framework, Sustainable Packaging, User experience

Introduction

Background of the Study

Global pollution, particularly plastic pollution, has increased due to the build-up of disposable or non-biodegradable waste. The growing non-biodegradable and single use plastic waste poses a serious threat to the environment. Groundwater contamination, air pollution, land pollution, greenhouse gas emissions, climate change, and other forms of pollution are just a few examples which plastic pollution is already impacting negatively on life. COVID 19 impacted heavily on increased use of disposable items.

Food packaging plays a vital role in preserving goodness of foods while providing a tool for communicating business message to consumers on product and its attributes. Recent study showed that, packaging material constitute 65% of totals global solid waste (Ritchie and Roser, 2018) Sri Lankan situation is explained by central environmental authority echoing the same. This is urging the importance of implementing sustainable packaging concepts to the Sri Lankan food business. The majority of Sri Lankans' food basket contains milk and milk products which totals to 1500 rupees per month (Diwuldeniya and Weligamage, 2015). Yogurts are second only to imported milk powders and play an important role in day-to-day indulgence needs of Sri Lankan consumers. Current packaging formats of Sri Lankan yoghurts are considered as unsustainable as it is not recyclable. Hence implementing

sustainable packaging initiatives in yoghurt industry have a big impact on environment protection.

Significance of the Study

Organizations are looking for innovations on sustainable packaging in developing alternatives to switch from the existing plastic-dominated packaging to more eco-friendly packaging materials. As consumers become more conscious of the harm caused by plastics, they are choosing products with eco-friendly packaging. Suppliers of packaging materials and product manufacturers should start moving toward sustainable packaging right away or risk falling behind their rivals. Environmental protection laws and plastics regulations are getting tighter and tighter. Single use plastic creates huge environmental impact in Sri Lanka and government has imposed bans on certain single use plastics (e.g., ban on plastic package less than 100g). Also, there are limited studies on Sri Lankan consumer expectation and no study in dairy industry for sustainable packaging concept. Studies conducted on Sri Lankan context were more focused on impact of environmental consciousness for consumers buying behavior and limited studies(published) is available for Sri Lankan organization contribution on sustainable packaging implementation. The findings ought to be helpful to marketers, packaging manufacturers, and policymakers for understanding the market requirement

Research Objective

- To study on the consumer awareness in Sri Lanka for the SPS
- To identify the factors, influences the selection of the SPS
- To understand impact on identified factors on SPS
- To Prepare an action plan and road map for the implementation of SPS for yoghurts

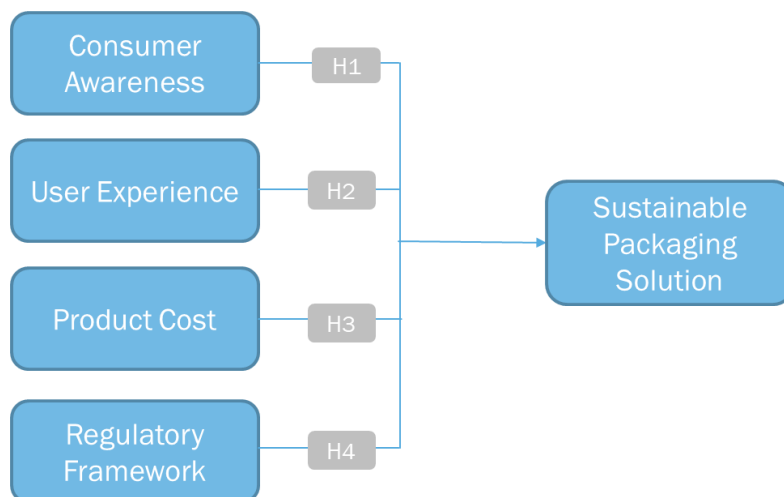


Figure 1: Conceptual model

Table 1: Hypothesis

Consumer Awareness	H1o – Consumer awareness has a relationship with successful implementation of SPS H1n - Consumer awareness has no relationship with successful implementation of SPS
User Experience	H2o – User experience has a relationship with successful implementation of SPS H2n - User experience has no relationship with successful implementation of SPS
Product Cost	H3o – Product Cost has a relationship with successful implementation of SPS H3n - Product Cost has no relationship with successful implementation of SPS
Regulatory environment	H4o – Regulatory Environment has a relationship with successful implementation of SPS H4n - Regulatory Environment has no relationship with successful implementation of SPS

Research Methodology

Based on literature review author has designed a questionnaire to test hypothesis, identified in here. Population was counted as 9639, daily yoghurt consumption is in 80g cusps. (LMRB Panel Testing data, 2022 June for western province).

The survey comprised with six sections and 28 questions. The first section contained questions soliciting demographic information such as gender, age, education, district, and yoghurt consumption pattern. Remaining five sections comprise series of question and statement to evaluate hypotheses 1-4. Data was collected by five-point Likert scale to measure the variables under each question from 1 to 5 (1 =strongly disagree, 5 =strongly agree). Author selected convenient sampling and number of respondents were limited in the study due to the time and resource limitation.

166 responses received and considered for the analysis. Pearson correlation was used to find the association between the dependent and independent variable; multiple regression analysis was utilized to test the hypothesis, developed in the study. Further, Cronbach Alpha reliability test and KMO validity test conducted with SPSS to measure the internal consistency and sample adequacy of the questionnaire

Data Analysis and Discussion

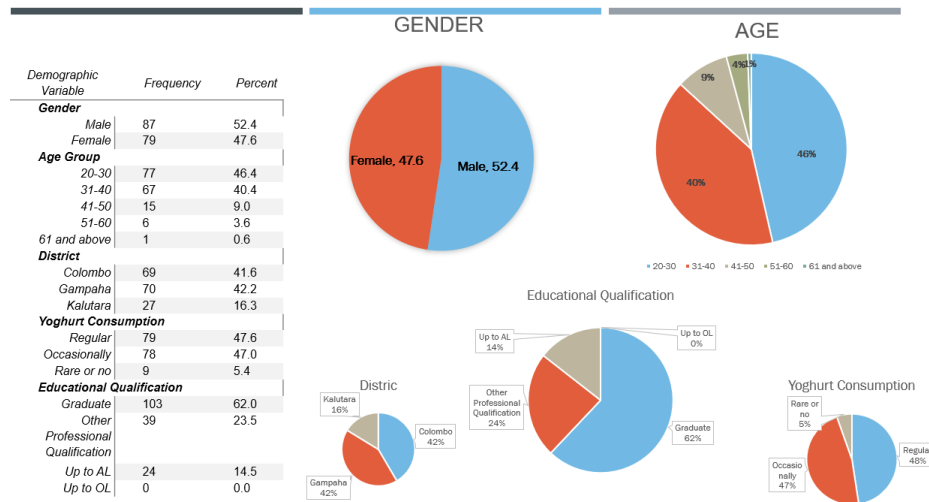


Figure 2: Demographic Data

Most respondents in the sample profile (52.4%) out of 166 total respondents, are men, while 47.6% of respondents are female. In terms of age, more than 46% (46.4%) of respondents are between the ages of 20 and 30. The age group with the least number of respondents those 61 and older represented only 1 and 0.6% of all 166 respondents. Additionally, out of 166 respondents, 67 (or 40.4 percent) fell into the category of respondents between the ages of 31 and 40. Majority of the respondents are holding a degree; they are about 62% and 24% having other professional qualification.

Majority of the respondents (96%) were aware on sustainable packaging and benefits. However, most of the respondents (96%) believe more awareness programs need to be conducted by government, Brand owners and manufactures.

Correlation Analysis

Table 2: Correlation analysis

		Consumer Awareness	User Experience	Product Cost	Regulatory Framework
Sustainable Packaging	N	166	166	166	166
	Pearson Correlation	0.470**	0.546**	0.394**	0.503**
	Significance (2-tailed)	0.000	0.000	0.002	0.000
Decision		Relationship exists	Relationship exists	Relationship exists	Relationship exists

**Correlation is significant at the 0.01 level (2-tailed)

According to the tabulated data above the Sig value (p Value) of the relationship is 0.000. (0.000<0.05) which indicates that alternative hypothesis is accepted, and null hypothesis is rejected for all predictors. There for all predictor showed positive relationship with sustainable packaging implementation. In summary “consumer awareness”, “user experience”, “product cost” and “regulatory framework” showed a positive relationship to sustainable packaging implementation.

Model Summary

Table 3: Multiple regression analysis

Model Summary	R² value = 0.396 / 40% contribution on the dependent variable			
ANOVA Table	Sig : <0.001b / Overall model is significant			
	Consumer Awareness	User Experience	Product Cost	Regulatory Framework
Standardized Coefficient (Beta)	0.188	0.320	0.021	0.277
Significance	0.01	0.000	0.784	0.000
VIF	1.430*	1.634*	1.592*	1.525*
Decision	Significant impact	Significant impact	Significant impact	Significant impact
*Multicollinearity does not exist				

R square value is 0.396 (39.6%) which means the four IVs represents the DV 40% of variation. In summary Consumer awareness (CA), User experience (UE) and regulatory framework (RF) showed a significant impact, whereas product cost (PC) did not show significant impact to model. Highest Beta value showed in user experience. Impact of each predictor is UE>RF>CA>PC.

Mean Analysis of User experience

Mean values of the indicators are awareness-4,17, Communication – 4,57, Convenience – 4.21 and previous experience – 3.87. Considering the above findings, it is evident that except previous experience has mean value above 4.0 which is Agree in the Likert scale (4 – Agree). Therefore, the researcher can safely conclude that awareness, Communication, Convenience impact on user experience

Conclusions and Recommendations

Conclusions

Study was designed to understand factors influencing successful implementation of SPS. Based on outcome of literature review author developed a conceptual model and hypothesis were developed accordingly. Results based on the answers from an online questionnaire from 166 respondents showed statistically significance that consumer awareness, user experience and regulatory framework positively impact on sustainable packaging delivery. Even though product cost does not show a significant impact on sustainable packaging implementation, it showed positive relationship. Approximately 40% of variation is described by model proposed by the author. Based on the outcome of the study, author can conclude that, all research objectives were successfully met.

Recommendations

Based on study User experiences play an important role in sustainable packaging, and it is recommended for the manufactures to think PLA and use of paper plastic cusp where same user experience is guaranteed. Marketers, government body need to think, how to increase consumer awareness on sustainable packaging. Eg: green labelling, green mark, green promotional campaign like Nestles's Earth is our only playground

Implementation of SPS is not only a manufacturers responsibility, and it must be a collective effort of government, importers, manufactures, researchers, garbage collectors, recycling

plants, marketers, and public. Industry wide moment required for sustainable packing and force policy makers to revisit national action plan. To change consumer behavior to promote the use of sustainable packaging, aspects like understand demographic variables, economic situation is still necessary and further research are required on same. To expand the conclusions of the current study, the investigation should be expanded to a nationwide scale soon.

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THE EFFECT OF ELECTRONIC WORD OF MOUTH MARKETING ON CONSUMER PURCHASE INTENTION IN XYZ CLOTHING BRAND.

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Abstract

The rapid expansion of the internet has empowered clients and increased their interaction. This has resulted in phenomenal growth in electronic word-of-mouth (eWOM) communication. This is encouraging consumers purchasing intention in this easier, wider, and faster communication. The XYZ Clothing brand can be identified as a company which recently growing through the online platform. Due to the lack of empirical studies on this context, this study is aimed to identify the impact of electronic word of mouth marketing on consumer purchase intention in XYZ Company. 384 customers were selected from the western province as the sample of the study and quantitative data collected through a self-administrated questionnaire. Data was analysed based on multiple linear regression analysis. According to the proposed research methodology this research was carried out to find the impact of consumer reviews, characteristics of reviewer, environmental influence, and interpersonal influence towards the consumer purchase intention in XYZ Company. Through evaluating the gathered information conclusions and recommendations have given for enhancing the future growth of the company.

Key words: Consumer reviews, Characteristics of reviewer, Consumer purchase intention, Environmental influence, and Interpersonal influence.

Introduction

Word of mouth marketing has evolved into a new type of communication that takes advantage of modern technology. This type of communication is known as electronic word of mouth (eWOM) (Almana, et al., 2013). Due to the higher level of awareness of the society toward this modern technology organizations have moved to use several strategies to promote their brands through online platforms (Zhao, et al., 2020). Hence, this study is focus on different research studies related to selected dimensions. Ratings and review qualities are essential aspects that impact consumers' purchasing decisions. Because consumers are increasingly using different social media channels to make purchasing decisions (Michelle, 2018). As a result, in an online world, businesses must engage with their clients via their website and social networking pages to ensure consumers may create trust and, alternatively, purchase from the company (Shah, et al., 2012). This research aim to investigate the impact of Electronic Word of Mouth (eWOM) marketing on customer purchase intention towards products in relation to the XYZ Company. As per this brand is a recently added to the industry, there is a lack of studied which have conducted on the different aspects related to XYZ Company. The significant aspect is, this clothing brand can be recognized as an organization which has highly depend on social media marketing. Yet eWOM concept applicability within this promotional platform has not studied. In the existing scenarios, most of the people are sharing their thoughts, through comments, feedback, recommendations, messages and other related method and they are showing a high response and evaluation

effort towards such aspects (Doh and Hwang, 2009) There is a lack of empirical studies which have focused on this recognized phenomena. Thus, researcher identified that it is worth to identify the impact of the concept of eWOM marketing on Customer purchase intention towards XYZ Company. This study will provide an understanding about the way that the organization has reinstate their marketing effort based on the insight on eWOM related aspects including customer reviews, characteristics of customers, environmental and interpersonal influence. From this study, marketers of this company and other related textile organizations can understand the Sri Lankan market and the mind-set of Sri Lankan customers. Research findings will provide more insight to the future researchers, university students and educationalists to enhance the knowledge regarding eWOM within existing textile industry.

Primary Research Objective

- To investigate the impact of Electronic Word of Mouth Marketing on consumer purchase intention of XYZ clothing brand.

Secondary Objectives

- To investigate the impact of customer reviews on consumer purchase intention of XYZ clothing brand.
- To investigate the impact of characteristics of reviewer on consumer purchase intention of XYZ clothing brand.
- To investigate the impact of environment influence on consumer purchase intention of XYZ clothing brand.
- To investigate the impact of interpersonal influence on consumer purchase intention of XYZ clothing brand.

Methodology

The main objective of this study was to study the effect of electronic word of mouth marketing on consumer purchase intention towards the products of XYZ Clothing brand. Study was explanatory in nature and deductive approach has implemented with research questions reviewing. The student has conducted as a cross sectional one. The target population of the study is defined as people from the Western province. Out of 6,219,000 customers from the Western province, 384 customers are selected under 95% confidence level by using the convenience sampling technique due to the unavailability of a specific sampling technique. Data was collected from the sample through a self-administrative questionnaire which consisted three parts in relation to the basic information of the respondents, eWOM elements, and customer purchase intention. Five point Likert scale measures were implemented to measure variables related data.

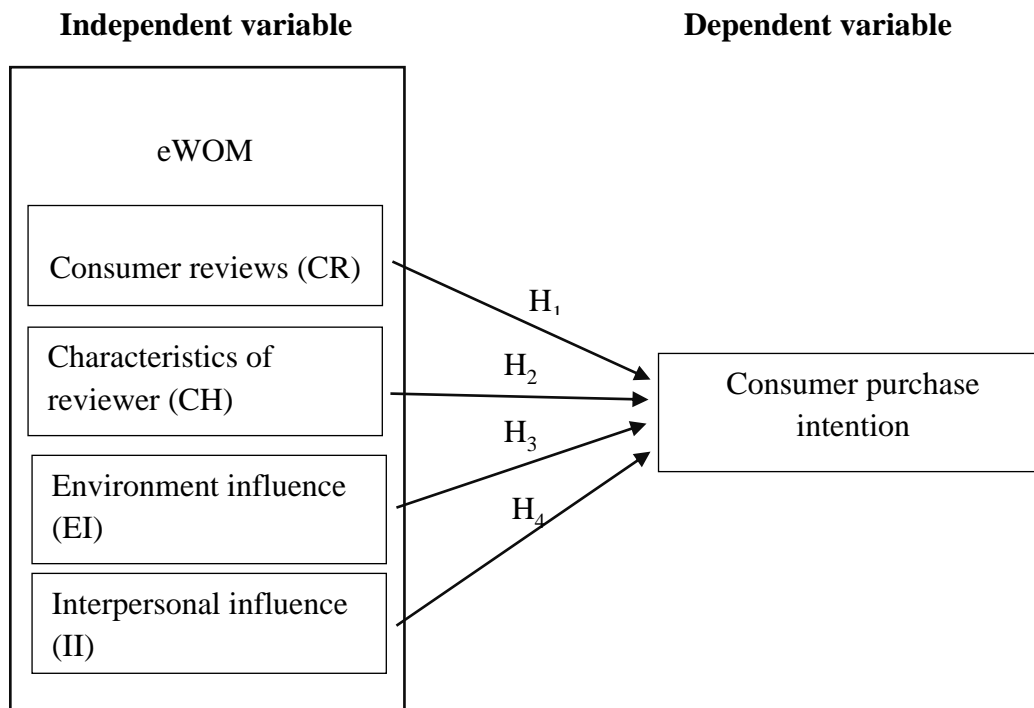


Figure 1: Conceptual Framework

H₁: There is a significant impact of consumer reviews on purchase intention of XYZ clothing brand.

H₂: There is a significant impact of characteristics of reviewer on consumer purchase intention of XYZ clothing brand.

H₃: There is a significant impact of environment influence on consumer purchase intention of XYZ clothing brand.

H₄: There is a significant impact of interpersonal influence on consumer purchase intention of XYZ clothing brand.

Results

Multiple Linear Regression Analysis

Table 1: Coefficients

Model	B	Std. Error	t-value	P-Value
Constant	0.955	0.154	6.200	0.000
CR	0.200	0.071	2.813	0.005
CH	-0.019	0.061	-0.315	0.753
EI	0.408	0.082	4.984	0.000
II	0.186	0.072	2.576	0.010

Source: Analyzed statistical output from field survey

$$CPB = 0.955 + 0.200CR - 0.019CH + 0.408EI + 0.186II + \epsilon$$

Table 2: Model Summary

Figure	Value
R Square	0.579
Adjusted R Square	0.574
Std. Error of the Estimate	0. 58871
Durbin Watson	1.445

Source: Analyzed statistical output from field survey

Table 3: ANOVA Table

Model	Sum of Squares	df	Mean Square	F-value	P-Value
Regression	160.109	1	160.109	392.250	0.000
Residual	160.823	384	0.408		
Total	320.932	383			

Source: Analyzed statistical output from field survey

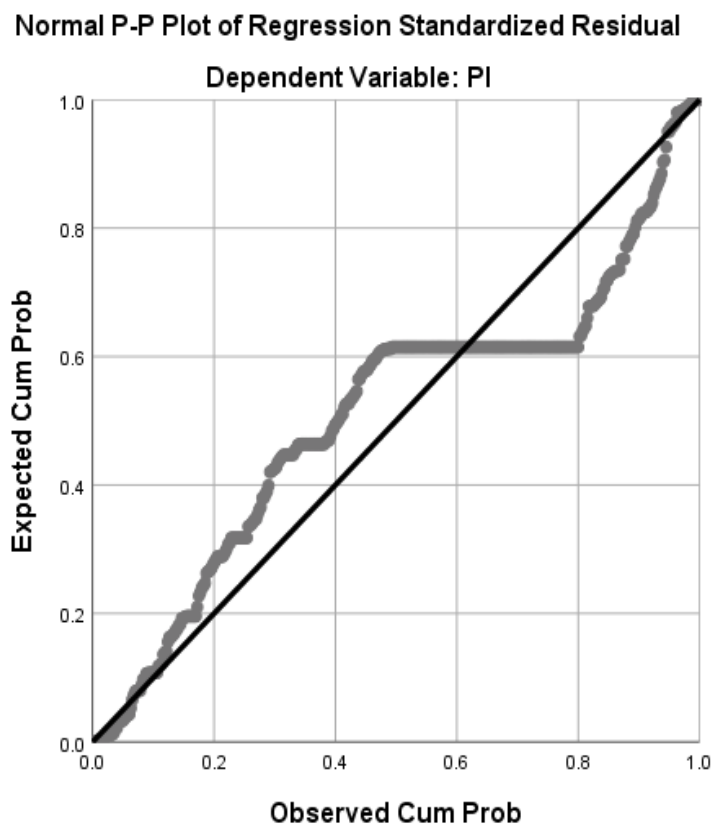


Figure 2 - P-P Plot

Source: Analyzed graphical output from field survey

Discussion

The consumer purchase intention will be equal to 0.955, when the eWOM related aspects are equal to zero. As per the regression model, there is a positive and significant impact of consumer purchase intention in relation to this clothing brand. When the consumer reviews increase from average one unit while characteristics of reviewer, environment influence and interpersonal influence are equal to zero, the consumer purchase intention will increase by 0.200. Further, if it is characteristics of reviewer, environment influence and interpersonal influence the average change of the purchasing intention of consumers will equal to -0.019, 0.408, and 0.186 respectively. According to the previous literature, the online recommendations has huge impact for the businesses (Cheung, et al., 2009). On the other hand, consumers can directly share or post experiences and rate firms or brands as per their perspective (Sulthana and Vasantha, 2019). As per the p-values, H₁, H₃, and H₄ can be accepted as the p-values of the model are lower than 0.05. Yet the P-value in relation to the CH is higher than 0.05. Thus, H₀ failed to reject and H₂ is fail to be accepted. The present student supports these previous findings with above illustrated results.

Furthermore, eWOM enables consumers to reduce time and effort in order to obtain information about specific products or services (Yang, et al., 2015). Furthermore, the R square value of the model is illustrating that, 57.9% of the purchase intention towards XYZ Company is collectively representing by the independent variables. According to the table 03, the p-value is 0.000. The model is significant at 95% of significant level and the null hypotheses can be rejected ($0.000 < 0.5$). Thus, the main objective of the student can be achieved.

Conclusion and Recommendations

The findings of the empirical study indicated that, eWOM factors have created a significant impact on the consumer purchase intention of this company. XYZ clothing brand needed to devise strategies to better adopt eWOM marketing. Policy makers needed to improve their better unique way by using social media to sell their products. This study shows that consumers 'buying decision is based on the buyers' recommendations. For that different interpersonal factors and environmental factors are affected. Hence, This shop needed to identify find the most clients-active platforms, where their potential buyers are interacting, so they need to collect more data and patterns about their prospects, to build and design distinctive competitive advantage that affects the consumers purchasing intention in the future. Further, this study was recommended to focus on the YouTube marketing platform also. Micro celebrities related word of mouth marketing strategies are suggested to implement with the brand since the organization has not used it .Because currently they are mostly focus on the Facebook marketing platform. Since the characteristic of the customer are creating a low impact on the existing level of purchase intention, the organization should implement promotional campaigns after conducting proper market researches and by identifying customer requirements and relevant customer touch points.

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**IMPACT OF TRANSFORMATIONAL LEADERSHIP ON INNOVATIVE WORK
PERFORMANCE OF EMPLOYEES IN INTERNATIONAL SCHOOLS OF
SRILANKA DURING COVID 19 PANDEMIC**

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Abstract

The main purpose of the study is to identify the impact of Transformational leadership on innovative work performance of employees in international schools of Sri Lanka during Covid 19 pandemic. The study is centered on ABC college, Kandy which experienced rigorous automation and process innovation during the Covid pandemic outbreak. The sample size used was 120 academic staff according to Anderson sampling table and followed a two stage clusters sampling technique where the respondents are selected from three main clusters of the college namely foundation, primary and secondary. The data was analyzed using regression analysis. The findings suggested that three main dimensions of transformational leadership possess a significant positive impact on innovative work performance of employees during Covid pandemic. Further recommendations are provided to enhance employee satisfaction and performance through provision of financial and non-financial benefits which can inspire and motivate employees.

Keywords: Idealized influence, Individualized consideration, Intellectual stimulation Inspirational motivation, Innovative work performance

Introduction

In modern business context leadership plays a crucial role in achieving growth and success by an organization specially during the period of contingencies and uncertainties. The statistical survey published by UNESCO indicates the first wave of Covid 19 Pandemic initiated an adverse impact over 90 percentage of student population across 190 countries. The island wide lock down resulted in Sri Lanka from March 2020 directed the schools towards online virtual learning process which was a very new concept in Sri Lankan Education system (Abayasekara 2020). Nusair, et al. (2012) were successful in showing the significance of transformational leadership on innovation and organizational development highlighting the significance of training leaders on transformational leadership approach before implementing innovation.

An in-depth study performed by Marinas (2012) revealed that transformational leadership attributes are positively correlated with organizational commitment of employees which builds a strong sense of trust. As per the research performed by Jyoti (2016), Leader Member Exchange(LMX) Theory and measurement of satisfaction with the leader clearly exhibited the significant relationship between Transformational leadership and Work performance. Moreover, Nouri, et al. (2016) emphasized transformational leadership and knowledge management had a significant relationship with organizational innovation.

The Central bank report (2020) highlighted that the immediate spread of the virus across Sri Lanka resulted in urgent transition of physical work to work from home arrangements. The government organizations and schools faced critical issues in implementing virtual infrastructure in order to perform WFH concept mainly due to the poor computer literacy and infrastructure facilities. The Comparatively lower level of computer and digital literacy of Sri Lankans which was 30.8 percentage and 46.0 percentage respectively(Department of Census and Statistics 2021) resulted in difficulties in adapting in to virtual platforms(Central Bank of Sri Lanka 2018).The specific situation drove the private schools to seek the support of Google and Microsoft to introduce highly effective virtual learning platforms such as Microsoft Team, Google classroom, class Dojo etc., The situation created an opportunity for emerging technology driven fourth Industrial Revolution while fostering independent student learning process with creativity and technology. Hence this study reveals how the transformational leadership style opted by the leader of the selected organization created an impact on Innovative Work Performance of employees while adapting virtual learning platforms. The research findings will be important for the organizations to identify the effectiveness of the leadership traits and practices within the organizations which can immensely contribute towards achieving employee satisfaction and work performance.

Research objective

To recognize the impact of transformational leadership on innovative work performance of employees

Methodology

Conceptual framework

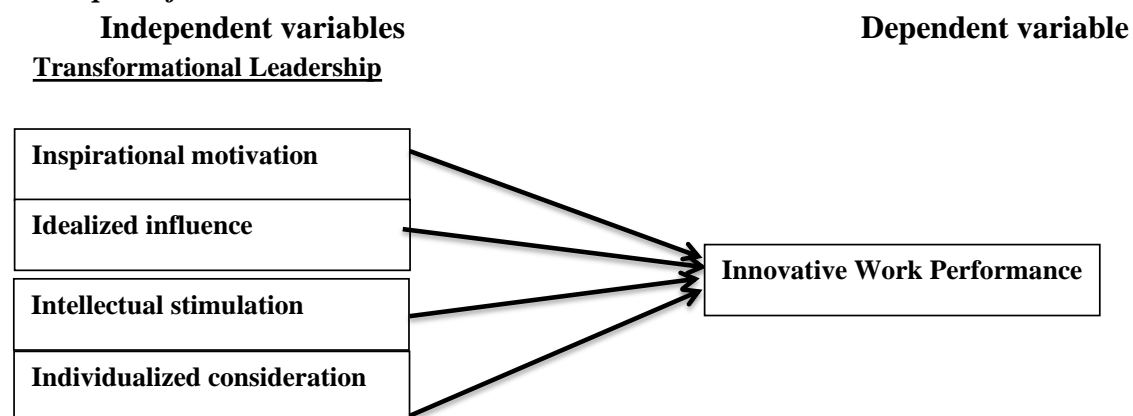


Figure 1: Conceptual framework

Transformational leadership is measured using four dimensions namely inspirational motivation, idealized influence, intellectual stimulation and individualized consideration. They are the independent variables. Innovative Work performance is the dependent variable and it is measured using three dimensions namely Task performance, Contextual performance and adaptive performance. The Task performance is measured using five factors which are Work Quality, Planning and organizing, result orientation, prioritizing and efficiency. The contextual performance is measured using five factors such as a Learning from feedback, effective cooperation, effective communication, creativity and challenge acceptance. The

adaptive performance is measured using three factors such as resiliency, knowledge and skill development, unpredictable work systems.

Hypothesis

H1: There is a significant impact of Transformational leadership on Innovative work performance of employees.

Study area and Data

The specific study exhibits an experimental research design where cause and effect situation are critically analyzed. The study analyzes the impact of transformational leadership dimensions (Independent variables) on innovative work performance (dependent variable) of employees where the significant relationship between the variables is hypothetically proven. The unit of analysis was academic staff members. The sample size was 120 out of 176 staff of the respective college according to Anderson sampling table with a confidence level of 95 percentage and with 5.0 percentage of margin of error.

A close ended structured questionnaire with a 5 point likert scale (1 means strongly disagree and 5 means strongly agree) is prepared which comprises of three sections as demographics, Transformational leadership dimensions and Innovative work performance. Further virtual interviews with the MIEE experts of the college are performed to gather reliable information on innovative work approach and practices implemented during the COVID 19 pandemic. In addition, the secondary data were gathered through featured articles of the college, annual review and official website of the college. Under ANOVA analysis Fit General linear model is used to express the contributory relationship between response (Innovative work Performance) and all the continuous Predictors (Dimensions of Transformational Leadership).

Results and Discussion

Descriptive statistics

Table 1: Descriptive statistics of the variables

Variable	N	N*	Mean	SE Mean	StDev	Minimum	Median	Maximum	Mode
Task Performance	120	0	0.7764	0.0129	0.1417	0.4000	0.8286	0.9714	0.857
Contextual Performance	120	0	0.7858	0.0129	0.1423	0.4000	0.8400	0.9600	0.88
Adaptive Performance	120	0	0.7459	0.0122	0.1339	0.3500	0.8000	0.9500	0.85
Idealized Influence	120	0	0.7967	0.0134	0.1477	0.4000	0.8500	0.9500	0.85
Individualized Consideration	120	0	0.7880	0.0129	0.1419	0.3000	0.8500	0.9500	0.85
Intellectual Stimulation	120	0	0.7967	0.0132	0.1454	0.4000	0.8000	1.0000	0.9
Inspirational Motivation	120	0	0.7708	0.0124	0.1363	0.4000	0.8000	1.0000	0.867

The following table provides a summarized analysis of the indicators used to measure Innovative work performance of employees.

Table 2: Mean and Standard deviation of Dependent variables

Variable	Mean	Standard Deviation	Mean+Std deviation	Mean-Std deviation	Range
Task Performance	0.7764	0.1417	0.9181	0.6347	63%-92%
Contextual Performance	0.7858	0.1423	0.9281	0.6435	64%-93%
Adaptive Performance	0.7459	0.1339	0.8798	0.612	61%-88%

According to the analysis centering Task performance about 95 percentage of the academic staff possess a satisfaction level between 63%-92% while 27 respondents possess a mode of 0.857(3 d.p).Further in terms of Contextual performance about 95 percentage of the academic staff exhibits a satisfaction level between 64%-93% and 42 respondents possess a mode of 0.88.According to the adaptive performance level of the respondents majority of the academic staff exhibits satisfaction level between 61%-88% where 30 respondents possess a mode value of 0.85.

The following table provides a clear overview about the contribution and satisfaction level of Transformational Leadership dimensions.

Table 3: Mean and standard deviation of Independent variables

Variable	Mean	Standard deviation	Mean+Std deviation	Mean-Std deviation	Range
Idealized influence	0.7967	0.1477	0.9444	0.649	64%-94%
Individualize consideration	0.7880	0.1419	0.9299	0.6461	64%-93%
Intellectual stimulation	0.7967	0.1454	0.9421	0.6513	65%-95%
Inspirational motivation	0.7708	0.1363	0.9071	0.6345	63%-91%

As per the results indicated in the table majority of the academic staff possess a satisfaction level for idealized influence between 64%-94% and a considerably small proportion possess a very high and very low level of satisfaction. The mode value for idealized influence is 0.85 with 42 respondents. Meanwhile majority of the academic staff possess a satisfaction level for Individualized consideration between 64%-93% with a mode value of 0.85 for 41 respondents. In terms of Intellectual stimulation, a greater proportion of the academic staff possess a satisfaction level between 65 %-95% with a mode value of 0.9 for 52 respondents. Moreover, when focusing Inspirational motivation majority of the respondents falls into the satisfaction level between 63%- 91% while possessing a mode value of 0.867 for 37 respondents.

Reliability analysis

Table 4: Cronbach's Alpha values of the variables

Variable	Cronbach's alpha
Task performance	0.9688
Contextual Performance	0.9667
Adaptive Performance	0.9692
Idealized Influence	0.9673
Individualized consideration	0.9684
Intellectual stimulation	0.9709
Inspiration motivation	0.9717

The overall Cronbach's Alpha value for the indicators is 0. 9733. Accordingly the individual and overall Cronbach values of the indicators clearly highlights that there is a strong internal consistency and they have passed the reliability test.

Regression analysis

Table 5: ANOVA table under Fit General linear model

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Idealized Influence	1	0.07219	0.072188	27.47	0.000
Individualized Consideration	1	0.01728	0.017283	6.58	0.012
Intellectual Stimulation	1	0.02253	0.022529	8.57	0.004
Inspirational Motivation	1	0.00741	0.007412	2.82	0.096
Error	116	0.30487	0.002628		
Lack-of-Fit	83	0.21428	0.002582	0.94	0.600
Pure Error	33	0.09059	0.002745		
Total	120	2.15274			

Model Summary

Table 6:Summary Table

S	R-sq	R-sq(adj)	R-sq(pred)
0.0512662	85.84%	85.35%	84.67%

According to the P-Values given in the table the significant relationship between the dimensions of Transformational leadership and Innovative Work Performance can be critically evaluated. The Idealized influence(X1) has a P value of 0.000 ,the Individualized Consideration(X2) possess a P value of 0.012 and the Intellectual stimulation(X3) possess a P value of 0.004. The specific three dimensions of Transformational Leadership has a significant impact on Innovative work Performance since the P value < 0.05. On the other

hand the Inspirational motivation (X4) which is the fourth dimension of Transformational Leadership possess a P value higher than 0.05(P Value=0.096).The specific value clearly indicates that there is no significant impact of Inspirational motivation on Innovative Work Performance of the employees. The R-sq(adj) value under model summary which is 85.35 percentage clearly depicts the overall contribution and impact of all the three dimensions of Transformational Leadership on Innovative work Performance excluding Inspirational motivation.

Conclusion and Recommendations

The research findings clearly support the hypothesis (H1) since there is a significant impact of Transformational leadership on innovative work performance of employees while rejecting H0 hypothesis. The regression analysis performed under fit general linear model indicates that the P value is less than 0.05 ($P < 0.05$) for Idealized influence, Individualized consideration, and Intellectual stimulation highlights that out of four dimensions the specified three main dimensions possess a significant positive impact on innovative work performance of academic employees. On the other hand, the Inspirational motivation which is considered as the fourth dimension of Transformational leadership has a P value greater than 0.05($P > 0.05$) which concludes that the specific dimension doesn't possess a positive significant impact on innovative work performance of the employees.

It is recommended for the management to implement the daily based hurdle system to identify the personal issues and workplace issues of employees. Further the HR teams and group consultants are recommended to implement a performance improvement plan.

As per the study performed by Organization for Economic Co-operation and Development (OECD) on rewarding systems, it is recommended for the management to implement a merit pay program which is centered on the portfolio of achievements of the academic staff, student performance in assessment and examinations and virtual classroom observations. This could be practically implemented through peer review and through reviews of team leaders, sectional heads, and principal. Based on the evaluation the academic staff should rewarded financially. Further the Chairman can set realistic targets for the academic staff members and provide timely appreciations by selecting and recognizing the top performers on monthly meetings. In addition, the chairman can provide special loan schemes with the support of leading commercial banks for the academic staff to follow Educational and professional qualifications and for the procurement of technological devices such as tabs and laptops etc., As a whole the specific recommendations can inspire and motivate the employees further to improve innovative work performance and system adaptability.

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IMPACT AND INFLUENCE OF SOCIAL MEDIA USAGE ON ONLINE BUYING INTENTION OF THE FASHION INDUSTRY IN SRI LANKA

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Abstract

Fashion industry as biggest income source for Sri Lanka from exports is vital for the country economy. Customer reaching platforms are in classical stage, which keeps an untouched area for the market. With the increased use of technology, Social media is becoming a routine habit of users. Considering Sri Lanka population as the customers, 196 individuals were identified for the sample study to collect *quantitative data*. (Data collection method used is questionnaire) The analysis was done based on the collected data (multiple linear regression). Data collection was separated to 2 main parts, demographic characteristics, and variable analysis. *Research objective* drives around the fashion industry and social media usage. Which focus more on factors the influence the buying intention in fashion industry, customer and relationship among them while providing recommendations. In conclusion, usage of social media and its impact towards fashion industry is shown a positive rate and relationship between factors highlighted as well.

Keywords: Brand Awareness, Consumer Buying Behavior, Fashion industry, Online buying Intention, social media

Introduction

In today's world, social media plays a significant role in online marketing and online purchases, as well as influencing consumer purchasing behaviors. Social media usage is increased and using for commercial purposes. In the last five years, the fashion or apparel business has been regarded as Sri Lanka's largest contributor to GDP. Even though there is a trend of using and benefiting from social media usage and online companies, previous research has shown some gaps, does not utilize appropriate material, does not cover all social media platforms outside of Facebook, and some businesses do not communicate with the appropriate audience. As a result, the researcher wanted to assess the impact of social media on fashion industry online purchasing intentions in Sri Lanka, as this can have a significant impact, and social media and online purchases have already begun to play major roles in the competitive market, and this industry must recognize and adapt accordingly.

After going through sufficient literatures, the researcher identified the social media related factors that have an impact on online buying intention and out of them chose the most discussed four independent variables and built sufficient number of arguments that led to find **the theoretical relationship has between the online buying intention and the chosen independent variables of Trust, Customization, Brand Awareness and User Generated Content**. Here the researcher used theories like Consumer buying behavior theory, the theory of reasoned and the theory of Planned behavior to explain how the mentioned independent variables can influence the online buying intention. After discussing the researcher designed the conceptual framework that used to develop hypothesis to see the relationship. This is descriptive research where the **deductive** approach used, and the **simple random sampling**

method was used to choose the sample. Online questionnaires used to gather data and SPSS was used to analyze and to present the findings. Identified that independent variables have a direct strong positive impact on the online buying intention and Trust was the most considerable factor that the respondents showed when providing their feedbacks.

The researcher has explained in detail what are the areas that the industry should improve to adopt to the situation and to expand the industry top line and bottom line.

Research Objectives are as below.

- To identify social media-related factors that influence online buying intention in the Fashion industry.
- To identify the relationship between identified factors and online buying intention
- To identify the influence made by each factor on the customer online buying intention of the industry
- To provide practical recommendations in the manner to cover the identified gaps of the industry.

Methodology

To methodically solve the research problem by answering each research question raised in chapter one and fulfilling the study's goals. Methodology covers the conceptual framework developed from literature-derived independent and dependent variables, hypothesis development, operationalization, sample selection, data collection, and analysis, as well as hypothesis development, operationalization, sample selection, data collection, and analysis. This study adopts a quantitative method, collecting primary data from a sample of the population using a questionnaire.

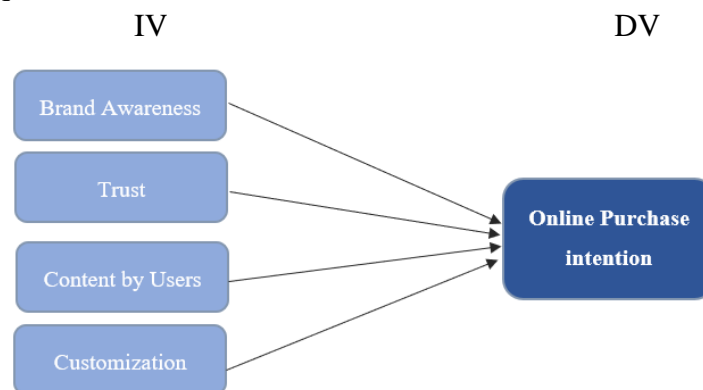


Figure 1: Conceptual framework

Independent variables are taken based on factors which will not affect on each other but will impact to the dependent variable (Online purchase intention).

The dependent variable and independent variables, as shown by the author in the conceptual framework, are used to create the hypothesis. A hypothesis is an experimental argument that aids in predicting what the experimental data will reveal based on the knowledge acquired from the literature.

Hypothesis

H1 – Intention for buying online in the Fashion industry in Sri Lanka has an impact on brand awareness.

H2 – Sri Lanka Fashion industry, online buying has an impact on Trust.

H3 - In the Sri Lankan fashion industry, User Generated Content has an impact on online buying intent.

H4 – Sri Lanka Fashion industry, online buying does have an impact from Customization.

Results

Correlation of Online Buying Intention Vs. Brand Awareness

Correlations			
		OBI	Brand_Awareness
OBI	Pearson Correlation	1	.661 ^{**}
	Sig. (2-tailed)		.000
	N	153	153
Brand_Awareness	Pearson Correlation	.661 ^{**}	1
	Sig. (2-tailed)	.000	
	N	153	153

**. Correlation is significant at the 0.01 level (2-tailed).

Figure 02 : Correlation of Online Buying Intention Vs. Brand Awareness

Since the correlation value is above 0.5 it means the relationship between these 2 values (Online Buying Intention and Brand awareness) is strong. Here the value is shown as 0.661. Sig(p) value stands for changeability is the survey is repeated. Since that P value is also 0.000 which is less than 0.05 it means the relationship is significant.

Correlation of Online Buying Intention Vs. Trust

Correlations			
		OBI	Trust
OBI	Pearson Correlation	1	.724 ^{**}
	Sig. (2-tailed)		.000
	N	153	153
Trust AVG	Pearson Correlation	.724 ^{**}	1
	Sig. (2-tailed)	.000	
	N	153	153

**. Correlation is significant at the 0.01 level (2-tailed).

Figure 03 : Correlation of Online Buying Intention Vs. Trust

If the correlation value is above 0.5 it means the relationship between these 2 values (Online Buying Intention and Trust) is strong. Here the value is shown as 0.724. Sig(p) value stands for changeability is the survey is repeated. Since that P value is also 0.000 which is less than 0.05 it means the relationship is significant.

Correlation of Online Buying Intention Vs. Content by User

Correlations		OBI	ContentByUser
OB	Pearson Correlation	1	.660 ^{**}
	Sig. (2-tailed)		.000
	N	153	153
ContentByUser	Pearson Correlation	.660 ^{**}	1
	Sig. (2-tailed)	.000	
	N	153	153

^{**}.Correlation is significant at the 0.01 level (2-tailed)

Figure 04: Correlation of Online Buying Intention Vs. Content by User

Since the correlation value is above 0.5 it means the relationship between these 2 values (Online Buying Intention and Content by User) is strong. Here the value is shown as 0.660. Sig(p) value stands for changeability is the survey is repeated. Since that P value is also 0.000 which is less than 0.05 it means the relationship is significant.

Correlation of Online Buying Intention Vs Customization

Correlations		OBI	Customization
OBI	Pearson Correlation	1	.637 ^{**}
	Sig. (2-tailed)		.000
	N	153	153
Customization	Pearson Correlation	.637 ^{**}	1
	Sig. (2-tailed)	.000	
	N	153	153

^{**}.Correlation is significant at the 0.01 level (2-tailed)

Figure 05: Correlation of Online Buying Intention Vs Customization

Since the correlation value is above 0.5 it means the relationship between these 2 values (Online Buying Intention and Customization) is strong. Here the value is shown as 0.637. Sig(p) value stands for changeability is the survey is repeated. Since that P value is also 0.000 which is less than 0.05 it means the relationship is significant.

Multiple regression is used to construct a model by combining all independent variables after accepting alternative hypotheses for all four variables using linear regression.

Correlations		OBI	Trust	Customization
OBI	Pearson Correlation	1	.724"	.637"
	Sig. (2-tailed)		.000	.000
	N	153	153	153
Trust	Pearson Correlation	.724"	1	.698"
	Sig. (2-tailed)	.000		.000
	N	153	153	153
Customization	Pearson Correlation	.637"	.698"	1
	Sig. (2-tailed)	.000	.000	
	N	153	153	153
Brand_Awarencss	Pearson Correlation	.661"	.681"	.630"
	Sig. (2-tailed)	.000	.000	.000
	N	153	153	153
ContentByUser	Pearson Correlation	.660"	.727"	.664"
	Sig. (2-tailed)	.000	.000	.000
	N	153	153	153

Figure 06: Correlations

After the analysis of independent variable with dependent variable it is identified all correlations provide positive feedback since all the P values are shown as 000. The four independent variables brand awareness, trust, content by user and customization will affect the net profit.

Discussion

The main purpose of the research was to measure the Impact and Influence of social media usage for online buying intention of the fashion industry in Sri Lanka. Four objectives were identified by the author to achieve the above target. Based on which recommendations were provided.

The researcher used Consumer buying behavior theory, rational behavior theory, and planned behavior theory to identify the theoretical background that influences consumer online buying intention, and after reviewing enough literature, the researcher chose the most discussed top four independent variables that influence online buying intention. This was a descriptive study with a quantitative questionnaire, and the researcher employed a basic random sample method and a deductive approach. After conducting a pilot survey to ensure the questionnaire's reliability, the researcher distributed the questionnaires online and collected data from 153 respondents, who were then analyzed using SPSS software to

determine the relationship and level of influencing power of each variable using Cronbach alpha, Pearson Correlation, and Coefficient values.

The researcher, on the other hand, used multiple regressions to determine the extent to which each independent variable contributed to the overall result. The researcher discovered that each independent variable had a significant positive link with the dependent variable after reviewing the data. As seen in the table below, each proposed alternative hypothesis has a significant positive link with the dependent variable, with Trust being the variable that has the most impact on the dependent variable. Under the conclusion, where the aims will be covered, the researcher will explain the table below in further depth.

Table 1: Hypothesis Test Summary

Title	Alternative Hypothesis	Relationship	Pearson Correlation	R Square	B - Value
H1A- Brand Awareness	Accepted	Strong Positive	0.661	43.6%	0.523
H2A - Trust	Accepted	Strong Positive	0.724	52.4%	0.517
H3A – Content by user	Accepted	Strong Positive	0.660	43.6%	0.453
H2A - Customization	Accepted	Strong Positive	0.637	40.5%	0.439

Conclusions and recommendations

5.1.1. Demographic Findings

With the 153 respondents who represented the whole industry's online buying intention, the researcher discovered that women 53% of the total, men contribute 47%. Also, when considering the age gaps, 41.1% (the highest number) from age group 26-35, and these findings aid in identifying the most appropriate target market that needs to focus more on increasing online purchasing, as well as other categories that need to improve.

Consumers increased being active in social media in today's business environment, 96% of respondents being active social media users, with 39% (the highest) claiming to use social media for more than 1-3 hours each week. Also, according to this study, Facebook is the most popular platform (28%), and Instagram is the second most popular platform (26%).

The most crucial finding is that count of 37 (maximum number) shop online more than once per week, which is close to the three times per week total (36 is the count).

5.1.2. Objective Achievement

Objective 1 – To identify social media-related factors that influence online buying intention in the Fashion industry in Sri Lanka.

This goal was achieved after a thorough assessment of the literature, and the researcher highlighted more than 10 elements that influence online buying intention in the Sri Lankan

fashion industry. Following that, the report's researcher identified the top four social media-related characteristics: **Trust, Customization, Brand Awareness, and Content by users.**

Objective 2 - To identify the relationship between identified factors and online buying intention

This objective was covered after conducting a thorough literature review in chapter two and constructing a **conceptual framework and hypothesis** in chapter three. In chapter two, some previous researchers' arguments were used to show that the four independent variables have a direct relationship with online buying intention, and the developed conceptual framework was used to develop hypotheses for each variable.

To illustrate how these characteristics might impact online buying intention and consumer behavior, the researcher employed the **Buying Behavior Theory, Theory of Reasoned Behavior, and Theory of Planned Behavior.** According to these theories, the independent factors described above fall within people's attitudes, subjective norms, and perceived behavioral control, and they have a direct influence on consumer buying behavior or intention.

Objective 3 - To identify the influence made by each factor on the customer online buying intention of the industry.

The study then discovered that, among the four independent variables, **trust is the most significant factor** that can *impact online buying intention, with an R square of 52.4* percent and a B value of 0.517. The influence of the independent variable on the dependent variable is represented by the R square and the B value. Furthermore, the Pearson value is 0.724, which is higher than the usual value of 0.5, indicating that trust has a significant positive link with the desire to make an online purchase. The remaining 25% might be due to other causes, such as PESTLE.

Customization has a high positive link with online buying intention, as seen by the Pearson value of 0.637, where the standard value is 0.5, the R square is 40.5 percent, and the B value is 0.439.

The brand awareness, which has an R square of 43.6%, a B value of 0.523, and a Pearson value of 0.661, indicates that brand awareness has a strong positive link with online buying intention.

lastly, the Pearson value for User Generated Content is 0.660, and the effect of User Generated Content on online buying intention is 43.6 percent (R²) and the B value is 0.453, indicating that it has a significant positive link with online buying intention.

Objective 4 - Recommendations

As the researcher has discussed in previous chapters, industry social media usage and consumer online purchasing intentions have increased in Sri Lanka over the last few years, and the COVID 19 pandemic has opened the gates for more online business transactions as it has become the new normal procedure.

Female participation is larger, according to the study, and the greatest online shopping age gap is between 25 and 35 years. As a result, while focusing on other groups, it is **recommended to focus more on the listed groups while implementing social media promotional campaigns.**

The most important factor influencing online buying intentions is trust. Customers are more worried about other suggestions before they complete an online transaction, as indicated in their questionnaires. Recommend **upholding commitments/ keeping the word both after and before the online transaction**. Also, **consumers are concerned about the reviews/ recommendations**.

Another way for the sector to acquire more customers is through customization. Recommend that they **provide more personalized items in their online stores**, as this would attract more consumers and create customer loyalty.

Customers are worried about the count of likes, reviews, and comments provided by previous users, therefore user-generated content plays a significant role. This is **not the same as what was addressed in the context of trust**. The previous purchasers' suggestions are used here. **Recommend enhancing industry social media sites to increase consumer interactions and stay active on social media platforms**.

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FACTORS AFFECTING EMPLOYEE PERFORMANCE WITH WORK FROM HOME: CASE STUDY OF SOFTWARE ENGINEERS IN ABC(PVT)LTD.

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Abstract

Software industry is a highly focus area in Sri Lanka for the contribution towards national economy being among the main exporters. Outbreak of Covid-19 pandemic made Working from Home (WFH) the new way of working which is a familiar concept for software industry. To make long term strategic decisions moving towards WFH in the new normal era, it's vital to identify factors affecting employee performance. The research objectives were set to study the effect of physical work environment, employee relations and motivation as factors that influence employee performance in context of WFH in Sri Lanka software industry. Sample of 62 Software Engineers in Service Management subdivision in R&D section of ABC(Pvt)Ltd were engaged in the study from a population of 72. This research was quantitative in nature and primary data was collected through an online survey based on structured questionnaire. The findings concluded that physical work environment, employee relations and motivation have positive impact on employee performance while employee relations have a slightly strong relationship towards employee performance.

Keywords: Employee Performance, Software Industry, Work from Home

Introduction

As all other sectors software companies were also forced to WFH with the unexpected closure due to COVID-19, but interestingly software industry was not completely affected negatively by lockdowns and had a smooth transition as some organizations had provisions to WFH partially/fully prior to pandemic. Sri Lanka was experiencing a deprived economy prior to the outbreak due to natural hazards, and terror attacks which was further adversely affected by the pandemic. Empowering the software industry as one of the top exporters was vital and sensible to overcome the post covid economic crisis in Sri Lanka. Thus, it is important to identify ways of enhancing WFH practices and strategically evolving to face such crisis in future as well. Further there are difficulties to count on available statistics and recommendations to continue WFH as the region of operation, communication methods, infrastructure and culture differs and there is very limited research done in this area.

Employee performance is an important aspect to bring the best out of employees to accomplish organizational targets. Research conducted during COVID-19 pandemic revealed that employee performance is impacted by leadership relationships, organizational support, work environment (Ollukkaran & Gunaseelan, 2012) (Aropah, et al., 2020) work life balance, satisfaction, and motivation (Susilo, 2020).

In terms of lighting, space and information technology aspects, office work environment is more satisfactory than home while it is more refreshed and concentrated at home (Umishio, et al., 2021). Conversely, distractions at home decreases performance (Madell, 2022).

Alternatively, every person needs support and guidance from co-workers, superiors, and management to be comfortable, concentrated, and productive at work. Samwel has identified that employee relations have significant impact on employee performance according to a study done in Tanzania prior to COVID-19 (Samwel, 2018). With WFH, having online conversations for a longer period, reduces engagement towards work and employees feels worn out and ineffective (Parker, et al., 2020). Further it is stated that interactions are limited to close networks (Baym, et al., 2021). Work motivation also influences employee performance which determines how well an employee initiate work and continue with work. WFH makes employees motivated with flexible hours and work-life-balance (Felstead & Henseke, 2017) (Fadzilah, et al., 2021) but conversely less interaction, isolation and misunderstandings due to communication barriers tend to demotivate employees (Ghosh, 2020). It is identified that employees are motivated during WFH by satisfying their intrinsic needs rather than bribing with payment advances (Sultana, et al., 2021).

Since there are limited studies that specifically focuses on impact of employee performance in Software industry with WFH this study is formulated as a case study concentrating Software Engineers related to Service Management division in R&D unit of ABC (Pvt) Ltd to accomplish below objectives. ABC (Pvt) Ltd is an enterprise software company that develops and deliver enterprise software for business related to manufacturing, distribution, asset management and services. Software Engineers focused on this study perform the tasks related to development, testing and maintenance of software solutions to solve real world problems. Knowledge of engineering principles and programming languages are applied in building software solutions.

Primary Objective:

- To identify the factors impacting employee performance related to WFH in Software Companies in Sri Lanka.

Secondary Objectives:

- To study the impact of physical work environment, employee relationship and motivation towards employee performance related to WFH in Software Companies in Sri Lanka.

Methodology

Conceptual Framework

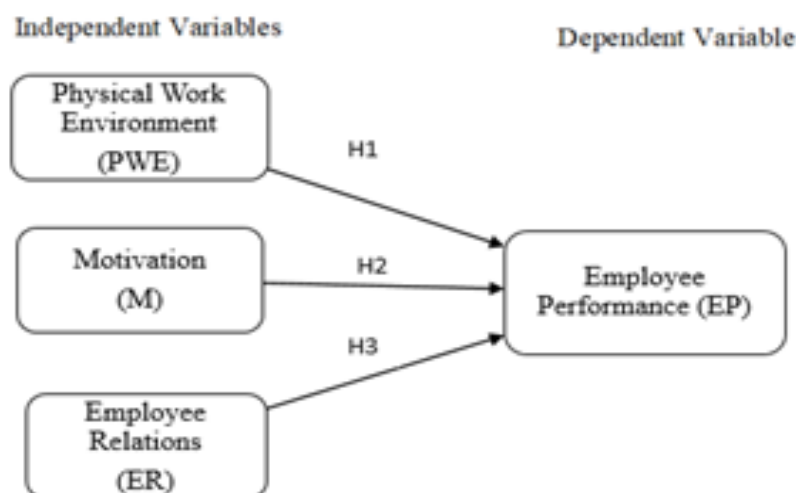


Figure 1: Conceptual Framework

Hypothesis

H1: Physical work environment has an impact on employee performance in WFH context

H2: Employee relations has an impact on employee performance in WFH context

H3: Motivation has an impact on employee performance in WFH context

Research Design

This study is based on data gained through an online questionnaire and is a quantitative approach where positivism nature of research philosophy is used. A deductive approach is used to analyze data through observations to prove theories. Time horizon is cross-sectional. Primary data was collected through a pre-structured online questionnaire via MS-Forms.

The questionnaire consisted of 31 questions sectioned to 5 areas: demographic, physical work environment, employee relations, motivation, and employee performance. 72 Software Engineers in Service Management subdivision in Research & Development unit of ABC(Pvt) Ltd, was selected as the population. Out of the total population of 72 Software engineers, 62 were selected using simple random sampling method.

Results

Reliability Analysis

A pilot study was conducted using 12 respondents prior to the main study.

Table 1: Pilot Study - Cronbach's Alpha Values (Author data based on SPSS)

Variable	Cronbach's Alpha	No: of Items
Physical Work Environment (PWE)	0.884	8
Employee Relations (ER)	0.827	5
Motivation (M)	0.882	6
Employee Performance (EP)	0.691	5

Number of 59 responses were received for the main study through the online questionnaire with a response rate of 95.2%.

Demographic Analysis

Out of 59 participants, 53% was Male respondents while 47% was Female. None of the participants were under 20 years and above 50 years. Majority of respondents were from 30-40 years range and above 5 years' experience. Therefore, the outcome should be realizable as they have had experience on pre-covid office work setup and WFH setup which would lead to better analysis and feedback comparing both work setups.

Descriptive Statistics

Physical Work Environment

As per the results in Table 2 it was identified that 81% employees were satisfied with the internet access and 89% were satisfied with availability of communication devices.

Table 2: Descriptive Analysis of PWE Variables

Label	Question	Mean	Strongly Agree and Agree %
PE1	I have a spacious work area separated from living space at my home	3.47	56.0
PE2	I have adequate internet access and speed at my home	4.05	81.4
PE3	The ergonomic design of the furniture in my home does not cause me any pain or discomfort (e.g., pain in my neck, shoulder, back, eyes)	3.31	50.9
PE4	I have sufficient communication devices at my home (phone, microphone, camera)	4.22	89.8
PE5	I experience sufficient ventilation and temperature level in home work place	3.78	67.8
PE6	The level of natural light at my home is comfortable and sufficient for working at home	3.97	76.3
PE7	Home work place is free from distractions and I find it easy to focus on my work	3.61	54.2
PE8	My home environment keeps my mental and physical well-being in a good state	3.80	67.8

Employee Relations

Analysis revealed only 42% employees agreed that relationships between teammates were satisfactory during WFH and majority were dissatisfied (refer Table 3). Conversely, the trust and support to each other was strong.

Table 3: Descriptive Analysis of ER variables

Label	Question	Mean	Strongly Agree and Agree %
ER1	I feel inspired to be able to maintain effective relationships with teammates similar to the office workspace	2.98	42.4
ER2	When something unexpected comes up at work, it is always easy to reach out and contact teammates to resolve issues on time	3.51	56.0
ER3	The employees trust and support each other in my organization and they are willing to collaborate with each other in remote work setup	3.95	84.7
ER4	Organization have conducted adequate knowledge sharing and training sessions to increase engagement for employees working from home	3.64	66.1
ER5	I believe the quality and frequency of communication between employees was exceptional, when working remotely	3.32	50.9

Motivation

56% of the sample were dissatisfied with the allowances provided for furniture, hardware, and technology. Alternatively, 83% strongly agreed that availability of appropriate WFH policies supports achieving objectives and 91% agreed that flexible work arrangements allow work life balance. Further 81% agreed that the organization has attractive medical and insurance allowances during WFH.

Table 4: Descriptive Analysis of Motivation variables

Label	Question	Mean	Strongly Agree and Agree %
M1	The organization has a standard and structured rewarding mechanism irrespective of where work is performed	3.80	72.9
M2	The organization recognizes and acknowledges the dedication and hard work done in a home work setup similar to the office	3.86	78.0
M3	Availability of appropriate Work from Home Policies and procedures are supportive to achieve goals and objectives	3.97	83.0
M4	The organization have introduced special allowances for Furniture, Hardware and Technology for employees working from home	2.98	44.1
M5	Flexible work arrangements allows to balance family commitments and work effectively	4.31	91.5
M6	The organization provides attractive non-monetary rewards such as medical, insurance and other well-being benefits even during working from home	3.93	81.3

Employee Performance

As per Table 5 it is identified that employees feel productive but the performance need improvement as well.

Table 5: Descriptive Analysis of EP Variables

Label	Question	Mean	Strongly Agree and Agree %
EP1	I complete more tasks when remotely working than I do in the office	3.85	67.8
EP2	The quality of tasks I perform during remote work is better than in the office	3.75	61
EP3	I spend less amount of energy on the completion of a task during home working	3.64	57.6
EP4	I engage more to work activities and meetings during home working	3.80	69.5
EP5	I am more capable of working and communicating with a team during home working	3.46	57.6

Correlation Analysis

Table 6: Pearson Correlation Values of variables (Author data based on SPSS)

Pearson Correlation	Physical Work Environment	Employee Relations	Motivation	Employee Performance
Physical Work Environment	1	0.568**	0.430**	0.339**
Employee Relations	0.568**	1	0.433**	0.558**
Motivation	0.430**	0.433**	1	0.448**
Employee Performance	0.339**	0.558**	0.448**	1

** Correlation is significant at the 0.01 level (2 Tailed)

As shown in Table 6 there is significant relationship between dependent and independent variables. There is a weak-positive relationship with variables Physical work environment and Motivation towards employee performance with the correlation values 0.339 and 0.448 respectively. Employee Relations and employee performance has a slightly strong-positive relationship with the best correlation 0.558.

Regression Analysis

Table 7: Model Summary (All Variables)

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.604 ^a	.365	.330	.5896
a. Predictors: (Constant), Motivation AV, Physical Work Env AV, Employee Relations AV				

The R square is 0.365 which means about 36.5% variations in the dependent variable Employee Performance is explained jointly by all the independent variables (Physical Work Environment, Employee Relations, Motivation)

Table 8: ANOVA table for all variables

ANOVA ^a						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	10.993	3	3.664	10.543	<.001 ^b
	Residual	19.117	55	.348		
	Total	30.110	58			
a. Dependent Variable: Employee Performance AV						
b. Predictors: (Constant), Motivation AV, Physical Work Env AV, Employee Relations AV						

According to Table 8, the p-value is less than 0.05 therefore the group of dependent variables (PWE, ER, M)) shows a significant relationship with the dependent variable Employee Performance.

Table 9: Regression Analysis All Variables

Coefficients ^a					
Model		Unstandardized Coefficients		Standardized Coefficients	
		B	Std. Error	Beta	t
1	(Constant)	.814	.620		1.313
	Physical Work Env AV	-.046	.158	-.039	-.292
	Employee Relations AV	.491	.142	.467	3.460
	Motivation AV	.355	.166	.262	2.134
a. Dependent Variable: Employee Performance AV					

With the above information the regression equation can be presented as follows:

$$Y_{\text{predicted}} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + e$$

Y predicted = Employee Performance (Dependent variable)

X1 = Physical Work Environment

X2 = Employee Relations

X3 = Motivation

$$Y_{\text{predicted}} = 0.814 - 0.046X_1 + 0.491X_2 + 0.355X_3$$

Hypothesis Testing

Table 10: Hypothesis 1 Test

Hypothesis	Regression Weights	Beta coefficient	R Square	F	t-value	p-value	Hypothesis Supported
H1	PWE > EP	2.194	0.115	7.396		0.009	YES

Note: *p < 0.05 Physical work environment (PWE), Employee Performance (EP)

$R^2 = 0.115$ in Table X illustrates that Physical work environment has a variance of 11.5% in Employee Performance and a significant impact exists. Findings are in line with literature which states favorable workplace environment contributes towards motivating employees and impact their engagement on work and performance (Naharuddin & Sadegi, 2013). Further it proves that physical well-being and mental health are equally important in perceiving employee performance (Tleuken, et al., 2022)

Table 11: Hypothesis 2 Test

Hypothesis	Regression Weights	Beta coefficient	R Square	F	t-value	p-value	Hypothesis Supported
H2	ER > EP	1.656	0.312	25.834		0.001	YES

Note: *p < 0.05 Employee Relations (ER), Employee Performance (EP)

$R^2 = 0.312$ in Table 11 illustrates that Employee Relations has a variance of 31.2 % in Employee Performance and a significant impact exists. Previous studies have also stated that isolation and less collaboration reduce motivation during WFH (Wolor, et al., 2020)

Table 12: Hypothesis 3 Test

Hypothesis	Regression Weights	Beta coefficient	R Square	F	t-value	p-value	Hypothesis Supported
H3	M > EP	1.393	0.201	14.307		0.001	YES

Note: *p < 0.05 Motivation (M), Employee Performance (EP)

$R^2 = 0.201$ in Table 12 illustrates that Motivation has a variance of 20.1% in Employee Performance and a significant impact exists. Aligning with literature WFH has become the new norm and makes employees motivated in the aspect of work life balance (Felstead & Henseke, 2017) (Fadzilah, et al., 2021) and tend to improve performance.

Analysis has proved among independent variables; Employee relations has a stronger relationship and greatest impact on Employee Performance compared to others. This is seconded by motivational factors and finally by the physical work environment.

This aligns with the previous study outcomes which states with WFH employee engagement and interpersonal trust has decreased which impacts employee relations (Bulińska-Stangrecka & Bagieńska, 2021).

Conclusions and Recommendations

Overall, the conceptual framework dependent variables have 36.5% of variance on employee performance. This concludes that there are more factors that impact employee performance which need to be revealed in future studies.

It is recommended to have separate and specific time schedules allocated during WFH and adhere to those schedules which might help to increase engagement as others try to stick to those schedules when making discussions. This concept has already been discussed as remote workers expect to have privacy, adequate lighting, and equipment to meet the same quality of office environment at home. One strategy would be to prepare the environment, which is conducive, dedicated with physical boundaries.

Unavailability of physical interactions with WFH has been stated as a major issue according to the study. Further it states even it is relaxed and refreshed at home concentration towards work is increased, but there are challenges in communication aspect (Umishio, et al., 2021)

The study recommends management to involve in encouraging and organizing frequent meetups with the teammates to increase collaboration between employees as individual performance is impacted by the influence from co-workers and how they use to transfer knowledge and skills between each other. Having team building activities and engagement activities was recommended to engage and strengthen the teams specially in Software industry as most employees work as teams.

To increase motivation employees have suggested to increase the hardware and internet allowances in accordance with the living standards as Sri Lanka is experiencing an economic crisis and fuel shortage, power cuts are frequent which impact the availability and performance of employees. Thus, it has been suggested that management need prompt response on such matters to have allowances to have backup systems to have an uninterrupted operation and to reduce the frustration of employees. In addition, proper policies for employee performance monitoring, reporting and evaluation need to be published and agreed upon to have a vibrant and fair evaluation process.

Apart from the factors studied in the research there are many more factors identified in literature that impact employee performance such as, performance evaluation methods, WFH polices, flexible hours etc. These factors have not been researched in terms of software industry specifically and with WFH context in Sri Lanka. Already there is very limited

research done in this area thus considered a highly potential area for research. Further involvement of larger populations is recommended to get broader outcomes and suggestions.

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ANALYSIS OF BARRIERS OF WOMEN IN HOSPITALITY INDUSTRY SRI LANKA: A CASE STUDY

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Abstract

The role of women plays a major role in developing countries economy. Most studies have discussed this importance even if women less representation is still existing. Objective of the study is to analyze the entry barriers of women to the operational level/non-executive level of a selected Sri Lankan tourism company and to analyze the barriers for women career advancement. This study used face-to-face semi-structured interviews and secondary data collection methods. Interviews were conducted with female employees whom were selected purposively. Thematic data analysis approach was used to analyze the qualitative data. Findings revealed that entry barriers of women to the operational level/non-executive level for hotel industry are physical demands of operational level jobs in hospitality sector, management's intention of hiring multi skilling employees, negative perception of the society about the industry and the negative perception among male managers, who owns a major proportion of the management, about the capability of women is the main barrier to the career advancement of women executives in the hospitality sector. The findings contribute the management to develop policies to increase women representation in the industry.

Key Words: Career advancement, Entry barriers, Hospitality industry, Sri Lankan women

Introduction

Sri Lanka is in the rank of 74 out of 187 countries according to the U.N Global gender inequality index. It is a green light about future gender equality in Sri Lanka (Borgen, 2020). Major proportion (53%) of Sri Lankan population is women. However, from that 74.8% are economically inactive (Gunasekare, 2015). Adult women unemployment rate (13%) is higher in Sri Lanka compared to men (Department of Census & Statistics, 2022; Asian Development Bank, 1999). Especially even in the situation women tend to be more success in college level (Silva, 2018), literacy rate among women is 91% (Fedec & Sausa, 2022). Most of organizations, scholars have paid their attention on Sri Lankan women (Asian Development Bank, 1999) about factors effecting women labour force participation (International Labour Organization, 2016), barriers for women career advancements (Gunasekare, 2015; Kuruppuarachchi, 2019; Weerahannadige, 2011).

Tourism and Hospitality sector holds a significant role as the main revenue generator in Sri Lankan economy. The national policy document "Vistas prosperity and splendor" also highlighted the importance of this sector and upward the tourist arrivals and tourism earnings to 10 billion USD in the year 2025. This policy also indicates the importance of women's empowerment in the hospitality sector. Empowering women will be helpful for the country's economic growth. It has been counted that; 25000-30000 job vacancies open in the Sri Lankan hotel sector. Even if country hotel schools provide around 10000 employees for the sector. World records 54% women enrollment in the hotel industry while Sri Lankan

represents below 10% (Wijayasiri, 2020). There are many studies about Sri Lankan women in hotel industry under different themes. Mendis, 2017 and Nanayakkara, 2015 has paid their attention on women in hotel industry. The other themes found are woman's place in hotel management (Ryan, 2009), career development (Kumara, 2018), internal barriers for women career advancement (Kularathne, 2015), their voluntary reluctance or voluntary preference to work (Kodagoda, 2022) and women's empowerment (Ramanayaka, 2012).

The study was done for one of the leading hotel chains in Sri Lanka. It will be addressed as XYZ Company. XYZ Company has several star-class hotels in Sri Lanka and overseas also. It has marked more than 5 billion in revenues with effecting for the year 2021 from more than 1200 employees. And it has covered more than 220 000 guest nights in the respective year. The company promotes equal opportunities for both genders however, women representation was exceptionally low. In the year 2020/21 total female representation was only 6%. At the management level, it was 13%. Especially there is a huge problem in women's representation at the non-executive level rather than the executive level women employees (Annual Report, 2021).

Due to the research gap related to the specific hotel chain selected, further to explore the causes for this less women participation in hospitality industry the research question and objectives of this study were developed as follows:

- What are the main entry barriers of women to the operational level/non-executive level in the selected Sri Lankan tourism company?
- What are the barriers existing for women career advancement in the selected Sri Lankan tourism company?

Methodology

An inductive approach was used with data of qualitative nature in this case study to understand opinions and experiences and to do an in-depth analysis within a natural real-life context. Data were collected through face-to-face semi-structured interviews to explore participants' thoughts, feelings and real experiences using ten female employees who were selected purposively. These female employees were young and middle age (25 to 45 years), experienced for 5 to 20 years and represented non-executive and executive levels. Furthermore, exit interview data and company new employee recruitment process data were also used as secondary data. Interview guideline was prepared based on previous literature. All interviews were recorded and transcribed. The thematic approach was used in data analysis and was reported in a narrative style to know how participant perceives and make sense of their experiences.

Results and Discussions

Majority stated about the physical demands of jobs. For an example front office has all duties in standing. Housekeeping department has heavy duties like setting up beds and working in the laundry. Restaurant and kitchen are also heavy working departments. Respondents tend to define the work as heavy work when they work for lengthy working hours. Hotel industry has 24 hours running operating system which is arranged to a shift base working process. However as per the respondents, due to limited staff and high turnover rate most employees

have to work long hours and it cannot predict in which time they can leave. *“I never know a resigned girl due to harassments. All colleagues who gave up saying I cannot be stand for these long hours”*, said a receptionist who works in front office. *“We must work long hours, day and night shifts and split shifts which has short break with combined morning to night. No matter girl or boy we have to work speedily. Dinner allocation is more tired in peak days. We must do whatever supervisor says. Most girls are unable to formed for this practice. Supervisors are also trying to take these girls for normal practice this leads them more stressful, you know that be naive is difficult to work here.”* This is the idea of a restaurant hostess.

Management looks for multi skilling employees. Multi skilling means selection and training of staff for performing more than one job position within the process (Jones, 2007). It mainly due to the seasonal pattern of the business (Lee, et al., 2008). For an example management expects one employee to work as cashier, store keeper, to handle procurements as well. And for this situation they believe that a male can handle all these multi tasks than by a girl. *“When they receive an application for the vacant position I have heard every time that, it is easy us to select a boy for this position. Boy can work everywhere even cashier, stores or going out for purchasing, no need to worry about their security also. Even he asked for a high salary it is fine. Productivity is in high with boys. This dialog is common in every recruitment,”* said credit officer. Even though the company promotes equal opportunities for gender groups, during selection the policy is less promoted.

Negative perception of the society about the industry has also become a barrier for women who are willing to enter to the industry. Society used to criticize hotel-employed females. This is an idea of a female human resource executive, *“The housekeeping department had two girls who both resigned due to marriage..... One girl said her husband’s family does not like to work in the Hotel.”* A guest relation executive front office said *“Most of my relatives asked about reason to join for the hotel industry. They could not agree with my intention.”*

Furthermore, the study found major barriers to career advancement of women executives in the hospitality sector. Majority of managers are male and the negative perception among those male managers about the capability of women is the main reason. Most of male managers think that female employees are unable to give their maximum contribution to the company. This is an idea of a male HR manager *“As an example, Kitchen has a busy environment, and we believe head chef must be a male. Girls cannot deal with these high speed and capacity...”* As explained by the head of the department of food and beverage, *“If a female member can actively work as male yes, they can achieve higher positions. If not, the female member is unable to work long hours, male candidates have benefits to achieve higher roles with these concerns.”* Furthermore, one of a female accounts clerk said, *“There was a bookkeeping position, and I was the most qualified employee for that. But I was personally invited to GM’s cabin and said that I think that you can understand how responsible this position is and have to work with different people like suppliers and travel agents. Boys are also difficult sometimes. So, we have to offer this to another male employee. After they offered it to another male employee who was junior to me.”*

Conclusions and Recommendation

This research found that mainly physical demands of operational level jobs in hospitality sector, management's intention of hiring multi skilling employees, negative perception of the society about the industry are main entry barriers for women to enter into the non-executive level of the selected hotel chain. Further the negative perception among male managers, who owns a major proportion of the management, about the capability of women is the main barrier to the career advancement of women executives in the hospitality sector. These findings are useful for the administrative authority to develop policies to increase women representation of the selected hotel chain. Conducting an ergonomics study about the jobs and redesigning operational level jobs in a way which female can equally contribute is a pragmatic suggestion for addressing the barrier of physical demands of operational level jobs and management's intention of hiring multi skilling employees. Making an agenda of programs in joining hands with the society for example CSR activities is a strategy to correct the negative perception of the society and training programs for internal management to change the negative perception of the management. Further a quantitative study can be designed to generalize these findings.

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**A DETAILED STUDY TO UNDERSTAND WHETHER COVID-19 CHANGED THE
PERCEPTION OF LIFE INSURANCE - A CASE STUDY OF CONSUMER
BEHAVIOUR OF SOFTLOGIC LIFE INSURANCE PLC AVISSAWELLA ZONE**

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Abstract

The research is designed to examine whether Covid-19 affected Softlogic Life Insurance PLC Avissawella Zone's life insurance perception and behaviour. It focused on life insurance perception, demand, and awareness. According to earlier studies, socio-demographic and economic aspects, children's education, service quality, customer connections, minimising tax liability, and returns on investment are more important to customers than insurance's real purpose. The study covers a set period and a moderate sample. Qualitative research was utilised to uncover phenomena and their links and analyse data. The exploratory and descriptive analysis uses surveys to gather hypothesis-related data. An online Likert-scale questionnaire collected data. This study includes all Softlogic Life Insurance Avissawella policyholders. Stratified sampling method was utilised to choose 106 policyholders from the population. The study found a favourable association between life insurance awareness/demand and perception during the pandemic, with most sub-variables showing robust relationships. The variables that exhibited significant associations with the Perception of Life Insurance during the epidemic were then recommended, and the conclusion was drawn to enhance the company's future financial performance.

Key Words: Awareness, Covid-19 Pandemic, Demand, Perception, Softlogic Life Insurance

Introduction

Sri Lanka's economy has slowed due to the Covid-19 pandemic. In a country that is still in the process of developing, such as Sri Lanka, the healthcare facilities are not up to a high standard. During a global pandemic, the significant rise in the expense of medical care for individuals has brought more attention to the significance of having life or health insurance. They put their finances at risk if they have a serious illness or disease, a pandemic, or a life-threatening accident or injury. Financial risks cause many socioeconomic issues for individuals and families. Health insurance covers unplanned financial risks from health difficulties (Miller, et al., 2013). The Covid-19 pandemic has severely disrupted daily living in every region of the world. In the past, most people in Sri Lanka viewed insurance as a product that could be used for "investment" or "tax savings." After the pandemic, many people realised insurance was for "protection." Consumers' opinions of a company are shaped by their direct and indirect contacts with the brand and how they feel about it. The epidemic has spurred customers to research insurance policies and choose proper coverage to protect themselves and their families from unexpected events. When justifying the research problem, Softlogic Life needs to maintain the 10-year CAGR (Compound Annual Growth Rate) of 29%, compared to the industry CAGR of 14.3% (Softlogic Life Insurance PLC, 2021, p. 12).

Also, the Company focus on increasing the Company's GWP (Gross Written Premium) by more than 28.1% for 2022 compared to 2021 (Softlogic Life Insurance PLC, 2021, p. 24). Since the Company employs diverse resources to grow each year, it wants to know if the Covid-19 epidemic will affect its insurance business. (marketing money, employee time, etc.) Softlogic Life needs to increase the number of new businesses during the Covid-19 pandemic. Therefore, the researcher looked at the existing customer base and the likelihood of them becoming repeat customers instead of buying for their family members or recommending their friends and families. So, this study was conducted to determine whether the Covid-19 pandemic changed the Perception of life insurance customers of Softlogic Life Avissawella zone.

These are a few studies conducted between the demand and perception of life insurance and between awareness and perception of life insurance. (Nebolsina, 2021) examined US insurance demand during the Covid-19 epidemic. The analyses show that the US Covid-19 outbreak will boost insurance demand by 02 to 06 times, which will improve life insurance perception. According to (Little, 2021), many people now see life insurance as an essential safeguard against the Covid-19 pandemic. He hypothesized the Covid-19 epidemic would boost life insurance demand and the insurance industry. (Mahdzan & Victorian, 2013) measured the life insurance demand by formulating a framework that included factors like demographic issues, financial literacy and saving motives among the respondents. A McKinsey analysis (Balasubramanian, et al., 2020) suggests that since the Covid-19 pandemic began, life insurance demand may reduce due to three factors: a decline in the living standards of a segment of society, an increase in premiums due to a lower interest rate, and problems accessing medical tests. (Manik & Mannan, 2017) studied life insurance awareness among fifty Dhaka hawkers. They found a positive correlation between the awareness of life insurance and different knowledge-related issues of the perception of life insurance. According to (Morelli, 2020), the demand for life insurance among young people aged 18-39 has already increased during this Covid-19 pandemic. He also finds that 95% of people are willing to buy a life insurance policy and want to sign an insurance contract. (Ahmed, 2013) showed that there is a very low level of awareness and perception regarding the products of life insurance among rural villagers. (Chowdhury, 2021) reviews previous studies on Bangladesh's life insurance industry's issues and opportunities. It shows that the post-Covid-19 pandemic phase is a good opportunity to raise awareness of life insurance policies in the country. These previous research findings show a relationship between two independent variables and the dependent variable.

Additionally, Sri Lanka's life insurance penetration has been below 1% for the past decade (IRCSL, 2018). Sri Lanka's insurance penetration is low compared to other Asian nations, with 1.21% in 2016 (life 0.54%, general 0.67%). (Insurance Board of Sri Lanka, 2016). The statistics indicate that 16.39% (IRCSL, 2020, p. 35) of the population of Sri Lanka is covered by insurance purchased from a local provider in 2020. However, there is a gap in the empirical knowledge in respect of 'Whether the Covid-19 pandemic changed the Perception of life insurance customers of Softlogic Life Insurance PLC Avissawella zone'. Softlogic

Life, a subsidiary of Softlogic Holdings, has been operating as a top life insurer in Sri Lanka for the past 22 years. The company placed third in 2021 with a GWP (Gross Written Premium) of Rs 20.053 Billion in the life insurance industry. (Softlogic Life Insurance PLC, 2021)

Research Objectives

- To analyse the demographic profile of life insurance customers in the Softlogic Life Avissawella Branch during the Covid-19 pandemic.
- To determine whether there is any association between demand for life insurance and consumer perception of life insurance during the Covid-19 pandemic.
- To determine whether there is any association between awareness of life insurance and consumer perception of life insurance during the Covid-19 pandemic.

Methodology

Conceptual Framework

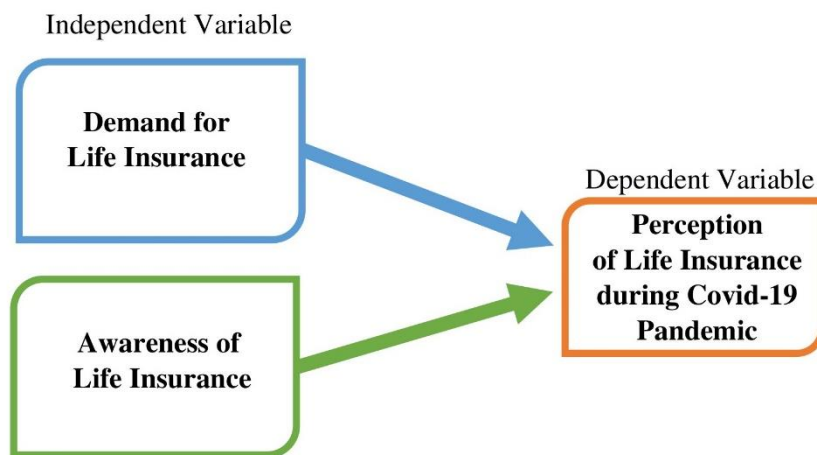


Figure 1: Author Compiled Conceptual Framework

Development of Hypotheses

H₁: There is a positive and significant relationship between the increased demand for life insurance and the perception of life insurance during the Covid-19 pandemic.

H₂: There is a positive and significant relationship between the increased awareness of life insurance and the perception of life insurance during the Covid-19 pandemic.

This is qualitative research based on primary and secondary data. Based on the questionnaire and secondary data, emphasis is on the aspects crucial to the perception of the life insurance business in Sri Lanka. A descriptive approach has been used for this study. This study's target demographic includes Softlogic Life Avissawella Zone's Softlogic life insurance policyholders. A stratified sampling method was used where policyholders from two branches were chosen randomly. Out of the Policyholders of Softlogic Life, 106 customers were selected as the sample of the study based on the 90% of confidence level and Margin of error of 8%. The online self-administrated questionnaire was used to collect data for the analysis as the research instrument. The questionnaire consists of 15 questions. The

respondents can respond with five responses, including a 5-point Likert scale method. The researcher used Microsoft Excel to transform responses into numerical formats for research. Then, IBM SPSS 26 Version was used to analyze the data safely.

Results & Discussion

Table 1: Demographic Profile

Factor	Variable	Number of Respondents	Percentage
Gender	Female	13	12.3%
	Male	93	87.7%
Age	18 - 24 years old	8	7.5%
	25 - 34 years old	29	27.4%
	35 - 44 years old	36	34.0%
	45 - 54 years old	26	24.5%
	Above 55 years old	7	6.6%
Marital & Family Status	Unmarried	25	23.6%
	Married with dependent children	62	58.5%
	Married with independent children	10	9.4%
	Married without children	9	8.5%
Employment Status	Employed Private Sector (Salaried)	18	17.0%
	Employed Government Sector (Salaried)	5	4.7%
	Businessman / Self-Employed (Freelance/ Others)	78	73.6%
	Retired	3	2.8%
	Other	2	1.9%
Education Level	High School	67	63.2%
	Diploma	16	15.1%
	Graduate	8	7.5%
	Post Graduate	2	1.9%
	Other (NVQ or Any)	13	12.3%
Household Monthly Income	Less than Rs.50,000/month	33	31.1%
	Rs.50,001 – Rs.75,000/month	29	27.4%
	Rs.75,001 – Rs.100,000/month	22	20.8%
	Rs.100,001 – Rs.125,000/month	11	10.4%
	Rs.125,001 – Rs.150,000/month	6	5.7%
	More than Rs.150,000/month	5	4.7%

As per Table 1, most policyholders in the age range of 35 - 44 years old (34%) are the most economically active and thriving in the community. And most of the policyholders in the sample were male customers (87.7%) because, generally, most of the males are heads of household and usually engage with the company. Also, the majority (73.6%) of the policyholders are business people / self-employed. The main factor that forms the demand for

insurance in these categories seems to be the "current availability of insurance". Because most employers are likely to provide at least basic life insurance, thus, it looks like more demand and awareness come from business people / self-employed individuals. And the majority (58.5%) of the policyholders are from under Rs.75,000 in Household Monthly Income. Most (58.5%) of policyholders are married and living with dependent children as they are more risk-conscious and seek protection for their families from Covid-19. The majority (63.2%) of the policyholders are only from high school education in their education level. Findings indicate that awareness and demand for life insurance exist at every educational level during the Covid-19 pandemic. Thus, it reflects that life insurance is an everyday necessity that transcends the education level.

Validity & Reliability Test

Table 2: ANOVA Table

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
Between People		179.296	105	1.708		
Within People	Between Items	1335.857	8	166.982	340.148	.000
	Residual	412.365	840	.491		
	Total	1748.222	848	2.062		
Total		1927.518	953	2.023		
Grand Mean = 3.10						

Table 3: Reliability Statistics

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardised Items	N of Items
.713	.702	9

Table 2 and 3 demonstrated that the instrument tool had a Cronbach's Alpha value of .713 and a Significance value of P 0.005. Therefore, the level of internal consistency was satisfactory, and the Research Tool was reliable and produced credible results.

Correlation Analysis

A Pearson correlation analysis can be carried out since the findings of the descriptive statistics show that the variables are being distributed ordinarily.

Table 4: Correlation Analysis

Correlations				
		Perception of Life Insurance	Demand for Life insurance	Awareness of Life insurance
Perception of Life Insurance	Pearson Correlation	1	.288**	.416**
	Sig. (2-tailed)		.003	.000
	N	106	106	106
Demand for Life insurance	Pearson Correlation	.288**	1	.150
	Sig. (2-tailed)	.003		.124
	N	106	106	106
Awareness of Life insurance	Pearson Correlation	.416**	.150	1
	Sig. (2-tailed)	.000	.124	
	N	106	106	106
**. Correlation is significant at the 0.01 level (2-tailed).				

Table 4, Demand and perception of life insurance correlated at a statistically significant 0.003 level with a Pearson Correlation Coefficient of +0.288. When life insurance demand is high during Covid-19, life insurance perception is also high. It means the variables are correlated. So, the **H₁ hypothesis is accepted**. Awareness and perception of life insurance correlated at a statistical significance 0.000 level with a Pearson Correlation Coefficient of +0.416. When life insurance awareness is high during Covid-19, life insurance perception is also high. It means variables are correlated. So, the **H₂ hypothesis is accepted**. Also, it was evident that perception of life insurance during the Covid-19 pandemic was moderately positively related to increased awareness of life insurance than increased demand for life insurance.

Multicollinearity Test

Table 5: Collinearity Statistics

Coefficients ^a			
Model		Collinearity Statistics	
		Tolerance	VIF
1	Demand for Life insurance	.977	1.023
	Awareness of Life insurance	.977	1.023
a. Dependent Variable: Perception of Life Insurance			

Since the tolerance value, the variance inflation factor, and Pearson correlations values are within the predicted range; multicollinearity is avoided. This allows for Multi-Regression analysis.

Multiple Regression Analysis

Table 6: Model Summary

Model Summary ^b										
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					
					R Square Change	F Change	df1	df2	Sig. Change	F Durbin-Watson
1	.475 ^a	.226	.210	.631	.226	14.996	2	103	.000	1.708
a. Predictors: (Constant), Demand for Life insurance, Awareness of Life insurance										
b. Dependent Variable: Perception of Life Insurance										

Table 6 suggests that 22.6% of the variants in the perception of life insurance during the Covid-19 pandemic were predicted from the level of independent variables. The Durbin-Watson statistic was 1.708, and it's between +1 and +3. So, the independence of the observation has been met.

Table 7: ANOVA Statistics

ANOVA ^a						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	11.938	2	5.969	14.996	.000 ^b
	Residual	40.997	103	.398		
	Total	52.935	105			
a. Dependent Variable: Perception of Life Insurance						
b. Predictors: (Constant), Demand for Life insurance, Awareness of Life insurance						

The F-ratio in the Table 7 tests whether the overall regression model fits the data well. According to these data, the regression model is a good fit for the data.

Table 8: Coefficients Statistics

Coefficients ^a						
Model		Unstandardised Coefficients		Standardised Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.159	.548		.291	.772
	Demand for Life insurance	.321	.122	.231	2.632	.010
	Awareness of Life insurance	.464	.107	.382	4.352	.000
a. Dependent Variable: Perception of Life Insurance						

Table 8, the unstandardized coefficient, β_1 (Demand) = 0.321. This means that for each one-unit increase in demand for life insurance, there is an increase in perception of life insurance of 0.321 times units. Also, the unstandardized coefficient, β_2 (Awareness) = 0.464. This means that for each one-unit increase in awareness of life insurance, there is an increase in

perception of life insurance of 0.464 times units. From that result, a regression equation can be derived for predicting the perception of life insurance during the Covid-19 pandemic from demand and awareness of life insurance.

Y predicted	= $\beta_0 + \beta_1 X_1 + \beta_2 X_2$
Y predicted	= $(0.159) + 0.321X_1 + 0.464X_2$
Y predicted	= Perception of Life Insurance
X1	= Demand for Life Insurance
X2	= Awareness of Life Insurance

Conclusions

The study examines whether Covid-19 affected Softlogic Life Avissawella zone's perception of life insurance. Perception, demand, and awareness of life insurance were the primary variables. Past research shows a relationship between two independent variables and the dependent variable. The study used qualitative research to uncover phenomena and their links and analyse data. The hypothesis was tested via a survey, a popular exploratory and descriptive research method. Data were collected using an online Likert scale questionnaire. There are three research objectives. According to Table 01, The 1st objective is to analyse the demographic profile of life insurance customers in the Softlogic Life Avissawella zone. According to the study's second and third objectives, both independent variables had a positive relationship with the dependent variable during the Covid-19 pandemic. Awareness of life insurance impacted the perception of life insurance during the pandemic. Customer satisfaction is not the only determinant of consumer perception of life insurance. This shows that life insurance clients' perceptions are always linked to other factors. This study's findings support that Covid-19 affected consumer perceptions of life insurance. The empirical data indicate that demand for life insurance and awareness of life insurance affect consumer perception. Also, this research framework for life insurance consumer perception can be applied to other insurance companies.

This study does not cover all the life insurance policyholders of Sri Lanka. The geographical selection of the Avissawella zone with medium population sizes is also considered a limitation. The study is focused only on two variables that focused on the perception of life insurance. And also, lack of resources and time to conduct proper combinative research, so time shortage negatively impacts my research. Due to the customers' busy work schedules, it was limited to engage with customers to gather information. Due to privacy concerns in the current context, people are afraid to give their personal details, are limitation of the study.

Recommendation

Softlogic Life needs to focus on the two variables that have a strong relationship with life insurance perception during Covid-19 and improve them based on the findings. It is recommended that a new insurance policy or coverage be introduced for Covid-19 or any other pandemic situation. SLI should develop plans that provide enough risk coverage for the Covid-19 pandemic to encourage long-term investment in insurance. According to the findings, existing policyholders are willing to spend more money on life insurance, and

customers expect more innovative policies with high returns and more policy benefits. Similarly, a new group insurance policy for Covid-19 should be made available to major enterprises such as garment factories and groups of companies. Some people have a low level of awareness regarding life insurance; therefore, its awareness should be promoted through advertisements or programs, along with an explanation of the necessity and significance of life insurance during the Covid-19 pandemic. Based on these findings, it is essential to hold training and development sessions with the newly recruited marketing teams of the company to increase the business during the pandemic. Finally, the researcher suggests that future research should examine the factors that determine perception during the Covid-19 pandemic by conducting interviews and focus groups discussion. This would provide a deep knowledge of the factors that affect life insurance perceptions during the pandemic.

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**FARMERS' AWARENESS, PERCEPTION AND ADAPTION OF NOVEL
TECHNOLOGY FOR RUBBER (*HEVEA BRASILENCIS*) CULTIVATION: A CASE
STUDY DONE IN KURUNEGALA DISTRICT**

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Abstract

Natural Rubber (NR) industry has a significant socio economic importance to the country. However, the industry suffered from key economic issues followed by low level of national NR production. The optimistic option remains us to elevate the national NR production is by increasing the productivity which is prompted the use of new technology for growing rubber. However, it is said that adoption of novel technology by rubber farmer's poor followed by low levels of awareness and perceptions about newly introduced technologies. Thus this study was carried out with the objective of investigating the farmer's levels of awareness, perceptions and adoption of novel technologies together with respective determinants. It was found that the awareness of farmers about novel technologies remain at a high level in the study area. The adoption of tapping related technologies and newly introduced clones found to be low which was followed by the poor perception reported among the rubber farmers under the investigation. However apart from the other new technologies, those who are educated and maintain large rubber lands tends to use new clones and tapping technologies having good perception towards such technologies

Key Words: Adoption, Awareness, Perception, Rubber smallholders, Technology for rubber

Introduction

Natural Rubber (NR) is a major contributor (Rs. 4017.6 million annually to the country's economy) (Central Bank, 2016), to Sri Lanka's economy, but the sector is facing challenges, such as low productivity and high input costs, leading to low local prices and market volatility. The smallholder sector, which makes up over 60% of total cultivation, is particularly affected. The introduction of improved rubber clones with higher yield potential offers a solution, but low adoption of recommended technologies remains a problem. This study aimed to investigate the adoption, awareness, and perception of new technologies by rubber smallholders in the Kurunegala District, and identify determinants for improving productivity. The results of this study can provide useful insights for finding solutions to improve the NR sector in Sri Lanka, particularly in the smallholder sector.

Methodology

Study Area

The study was carried out in rubber growing areas in Kurunegala District. It includes three Rubber Development Officers (RDO) ranges namely, Rideegama, Polgahawela and Alawwa. Since this area is at the border of Low Country Intermediate Zone and Low Country Wet Zone, the variability of the climate in this area is diverse. These areas are located in six agro ecological zones which are respectively, WM3a, IL1a, IM3b, WL3, WL2b and WM3.

Data Collection

Mature rubber smallholders in rubber growing areas of Kurunegala District were subjected to this study. New technologies introduced by the Rubber Research Institute of Sri Lanka (RRISL) on planting materials, rubber clones, tapping practices and standards, tapping utensils, management practices during fertilizing and weeding were the technologies considered in this study. Farm and farmer characteristics, income status, awareness, adoption and perception of the above-mentioned technologies of the farmers were measured in this study during the period from August to September 2017 using a pre tested semi structured questionnaire. The sampling procedure was a two stage sampling procedure. In the first stage Grama Niladhari (GN) divisions were randomly selected from a list of GN divisions in three RDO divisions. Rubber smallholders with mature rubber lands were randomly selected from the selected GN division using a list of mature rubber smallholders in the GN division. Distribution of GN divisions and rubber smallholders were done probability proportionately to the total number of mature smallholders in RDO ranges and GN divisions respectively. The final sample size was 150 after optimizing it to both time and cost functions.

Data Analysis

Numerical and graphical summary measures were used to understand the data on different variables considered in the study. The distribution of data on awareness, Adoption and perception are not distributed normally and thus there is no implication of normal distribution based statistical methods to analyze respective data. Data on awareness and adoption are dichotomous (Yes = 1 and No = 0) and thus the expected distribution of these data are binomial in nature. Therefore, a logistic model was used to analyze these data in the endeavor of identify underlying determinants of awareness and adoption of new technology for growing NR. The model form of a logistic regression model can be illustrated as

$$\ln \left(\frac{p}{1-p} \right) = \beta_0 + \beta'x + \epsilon \text{ ----- (1)}$$

where $p = p(Y = 1)$ and β_0 is intercept parameter. β' is a vector of parameters while x is a vector of covariates.

The perception of different technologies were measures based on a Likert scale of which the distribution is not normal. The perception of one technology was assessed using several questions and consequently the perception of the particular technology was counted as the average of the Likert rankings of respective questions. Thus application of multinomial logistic model is not clear. Therefore, single index regression model, semiparametric model

was used to analyze perception data where the normal assumption is more relaxed. Its model form is growing in equation 2 and Ichimura's estimator was used for parameter estimation (Ichimura, 1993).

$$y_1 = g(X'\beta) + \varepsilon_i \text{-----} (2)$$

where X is a vector of covariates and β is a vector of regression parameters. All the analysis were done using R 3.41 version and packages “survival” and “no” were respectively used to fit logistic models and semiparametric regression model.

Results and Discussion

The characteristics of both the farm and farmer play a significant role in determining their awareness, perception, and adoption of new technologies in rubber farming. The average age of the farmers surveyed is 54 years, with the majority being in their economically active ages. The average family size is 3.15, indicating low availability of family labor for farming. The average off-farm income is Rs 120,419.00 with 50% exceeding Rs 96,000.00. The average farm size is 1.25 Acres, with most being small in size and a high standard deviation of land resources, indicating inequality in the distribution of land among the community.

Table1. Summary statistics of selected farm and farmer characteristics

	Age	Ext	OFI	NFM
Min	28.00	0.20	14400	1.00
1st Qu.	46.25	0.53	70500	3.00
Med	53.50	0.80	96000	3.00
Mean	54.37	1.25	120418	3.15
3rd Qu.	61.75	1.20	120418	4.00
Max	82.00	10.0	535000	6.00
SD	10.67	1.45	89666	0.98

(Min-Minimum, Med-Median, Max-Maximum, Ext-Extent, OFI-Off-farm income, NFM-Number of family members, 1st Qu. = 1st Quartile, 3rd Qu. = 3rd Quartile)

The distribution of the education of the household head of this community of rubber smallholders are given in Figure 1. It can be seen that more that 90% of the rubber smallholders in the area have not continued their education until GCE (A/L) is completed. The distribution of the experience of rubber smallholders being engaged in rubber cultivation in this area is depicted in Figure 2. It can be noticed that more than 80% of the farmers in the sample have been doing rubber cultivation more than 10 years.

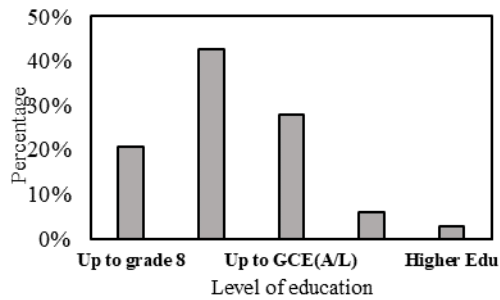


Figure1: Sample distribution of the education status of the rubber smallholders

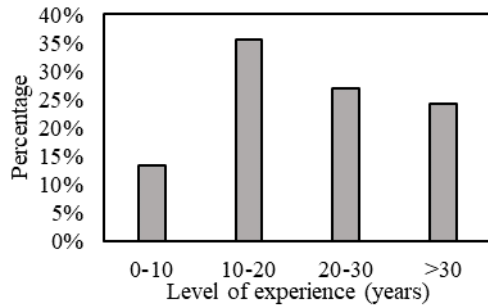


Figure2: Sample distribution of the experience of farmers in rubber cultivation

Awareness of Farmers on Novel Technology

The results of the model fitting for awareness in rubber cultivation showed that none of the selected farm and farmer characteristics had a significant impact on the farmers' awareness of new technology. The level of community awareness about different technologies, such as planting material, clones, tapping practice, tapping utensils, fertilizer management, and weed management, was found to be high and exceeded 95%. This may be due to the widespread and organized extension services available for rubber cultivation in the area, leading to minimum variability in awareness among the smallholders. The statistical analysis showed that the community's awareness is invariant to the selected covariates

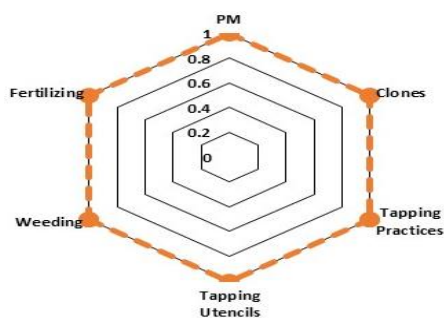


Figure 3: Community orientation of the awareness about different new technologies (PM-Planting material)

Perception of Farmers on Novel Technology

The results of a semiparametric regression on farmers' perceptions of new technology in growing rubber were analyzed. The three classes of technology were combined to reduce convergence issues. Education status and farm size were found to have a significant effect on

the perception of new technology. Perception of new planting material technology was lower among farmers with less education but higher among highly educated farmers. Farm size was the only significant factor influencing perception of tapping-related technology. Education and farm size also affected perception of new crop management techniques. The community's perception of new technologies is depicted in Figure 4 and shows a neutral perception towards new clones. The adoption of new technology was found to be affected by farm size, off-farm income, and education level. However, large farms and high off-farm income were negatively related to the adoption of new planting material technology, while education level was a significant determinant of adopting new clones.

Table 2: Results of the semi parametric multiple regression model fitted to perception data for three classes of novel technologies identified.

Covariate	Technology Related to Planting Material		Technology on Tapping		Other Technology Related to Crop Management	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
Age	1.000	0.278	1.000	0.451	1.000	0.526
Up to GCE(O/L)	-0.020	0.005	-4.202	0.706	-0.795	0.142
Up to GCE(A/L)	-0.075	<2.22e-16	41.556	0.240	1.808	0.068
GCE(A/L) and above	0.008	<2.22e-16	-196.457	0.366	1.137	0.048
Farm size	-0.006	0.010	49.127	0.038	-1.878	0.068
Off farm income	-0.0001	0.847	0.481	0.516	-0.066	0.732
Age	-0.016	0.491	68.883	0.148	0.411	0.241
R ²	0.540		0.180		0.440	
S of error	0.145		0.225		0.393	

Table 3:Results of the logistic model applied on the adoption of different new technologies by farmers in the study area

Determinant	Class of technology					
	PM	Clone	Tapping practices	Tapping utensils	Fertilizing	Weeding
Constant	-0.286	-0.235	-0.375	1.581	0.814	1.143
Age	0.018	0.025	0.022	-0.003	-0.008	0.020
Up to GCE(O/L)	0.772	0.741	0.169	-0.633	-0.106	-1.293
Up to GCE(A/L)	0.141	1.126*	-0.075	-0.687	0.240	-1.901
GCE(A/L) and above	0.453	1.203*	0.252	-0.332	-0.693	-0.929
Farm size	-0.243*	0.223	0.189	0.530*	-0.099	-0.392*
Off farm income	-0.004*	0.002	-0.005*	0.001	0.002	0.008
Family size	0.129	-0.034	0.248	-0.175	0.249	0.311

* denotes significant at 5% level

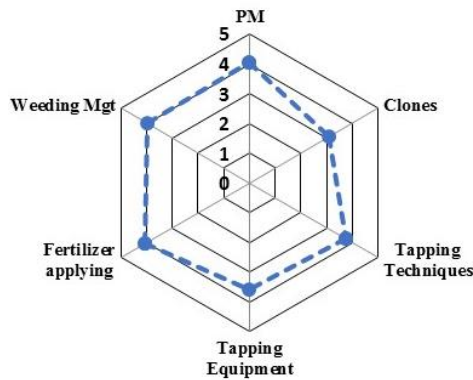


Figure 4: Community orientation of the farmer's perception regarding technologies introduced for six classes of technology

(Note: PM= Planting Materiials)

Since farmers are well aware about the new clones and they are encouraged to use newly introduced clones through well-established government subsidy program, the impact of other determinants could be invariant to adoption. However, the use of newly introduced is popular among more educated farmers. Based on the results in Table 3, except off farm income, none of the other determinant seems to be statistically significant on the adoption of newel tapping techniques. Based on this results those who earn more off farm income tends to weakly adopt new techniques introduced on tapping practices. For the technologies about tapping utensils, farm size can be recognized as the statistically significant determinant among other determinants considered in this study. Based on the results, those who have large farm sizes tends to use now technology related tapping utensils.

However, non of the dertiminents chosen in this study showed statistical significant on the adoption of fertilizer related technology by the farmers subjected to investigation. It was further found that farm size is a statistically significant deteminant on the adoption of technology on weed management. The community orientation with respect to expected probabilities of adopting various types technology by the rubber slallholder are dipicted in Figure 5. The expect rate of adoption of technologes of other categorised except clones and tapping utencils exceeds 80% of the community under investigation.

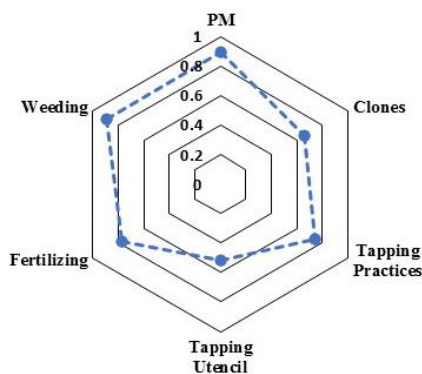


Figure 5: commnity orientation with respect to expected probabilities of adopting various types technology

(Note: PM= Planting Materials)

Conclusion

It can be concluded that the awareness of the farmers in the study population about various new technologies introduced for growing rubber remains at a very high level. The perceptions of farmers on the various technologies considered in this study remain at rather satisfactory level. However, perception on technology introduced for tapping and new clones comparatively at a low level. This study reveals that those who have small farms do not have good perception on those technologies about tapping and clones. Similarly, rubber smallholder with mature rubber lands reluctant adopt new clones and technology for tapping utensils. However, those who have high levels of education prefer to adopt newly introduced clones while use of tapping utensils is higher in large rubber holdings.

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THE IMPACT OF INWARD CHINESE INFRASTRUCTURE INVESTMENT ON THE DOMESTIC ECONOMY: EVIDENCE FROM SRI LANKA.

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Abstract

China is the main infrastructure project investor in Sri Lanka. Southern and Central expressways, Hambantota Port, Norocholai Power Station, Colombo Port City Urban Development, Mattala International Airport, Kandy North Pathadumbara Water Supply Project, Colombo International Container Terminal (CICT), and Lotus Tower Info and Communication Projects are the giant infrastructure investments from Chinese MNEs. This study revealed the economic benefits and drawbacks of Chinese infrastructure investments in Sri Lanka. National road connectivity, reduced journey time, enhanced road safety, increased business rankings and providing opportunities for new businesses and jobs, enhancement of telecommunication and power plants, diversification of ports, development of primary industries, and knowledge transfer to local labours are the major benefits for Sri Lanka from Chinese infrastructure investments. The trade deficit between the two countries, limited economic spillovers, and falling into Chinese debt traps are the main drawback of Chinese FDIs. Sri Lanka should improve its debt management systems to overcome the Chinese debt trap issue. Secondary data from previous research was used for the evaluation of the research topic.

Keywords: Economic growth, domestic spillovers, Chinese infrastructure investments, Sri Lankan context

Introduction

In the past few decades, many countries have been competing to entice foreign direct investments (FDI). Konara and Wei (2017) concluded that FDI is the driving force of economic growth. FDI and its agents, multinational enterprises (MNEs) have a positive impact on domestic companies in the host country. MNEs own firm-specific assets such as advanced knowledge and technologies and know-how and which are much preferred by domestic firms especially those in developing countries. According to Nam and Young (2004), FDI can enhance the productivity of domestic firms with an immediate effect on MNE's local affiliates. Further Moosa (2002); Wright, et al. (2005) implied that host countries and MNEs could yield mixed results from FDI spillovers. It can be positive, negative, or marginal spillover effects. Therefore, Irsova and Havranek (2013) stated that FDI provokes spillover that often benefits the domestic economy, labour force, and institutions in the host country.

As one of the greatest destinations for FDI, China has received substantial attention. Chinese outbound investments could lead to economic growth and technological progress in host countries (Gurel and Kozluca, 2022). Deng, et al. (2020) found that China aims for the belt and road to enhance investments and trade conditions. Chinese outbound investments in Sri Lankan infrastructure have spillover effects on dual-channel technology and trades.

This paper focuses on Chinese investments in Sri Lankan infrastructure development projects. There are many studies found on the manufacturing and service sector FDIs and

their impact on the Sri Lankan economy. Previous researchers were not addressed the economic impacts of infrastructure investments in Sri Lanka. Therefore, the author found that there is a research gap on the impact of infrastructure FDI on the domestic economy related to the Sri Lankan context. This study will illustrate the economic aspect, implications for labour, the environment, and institution outcomes from Chinese infrastructure investments. Further, this study analyses the positive and negative spillover effects brought by Chinese infrastructure investments.

Research Questions

- What are the impacts of inward Chinese infrastructure investments on the Sri Lankan economy?
- What are the spillover effects brought by Chinese infrastructure investments?

Methodology

The evidence-based approach is used for this research. The available literature from previous research and secondary data had been carefully reviewed. Sri Lankan Central Bank reports, government websites and previous research papers related to FDI had used to evaluate the research topic. This study comprises quantitative and qualitative data. The author focused on 2006-2019 inward Chinese infrastructure investments in Sri Lanka.

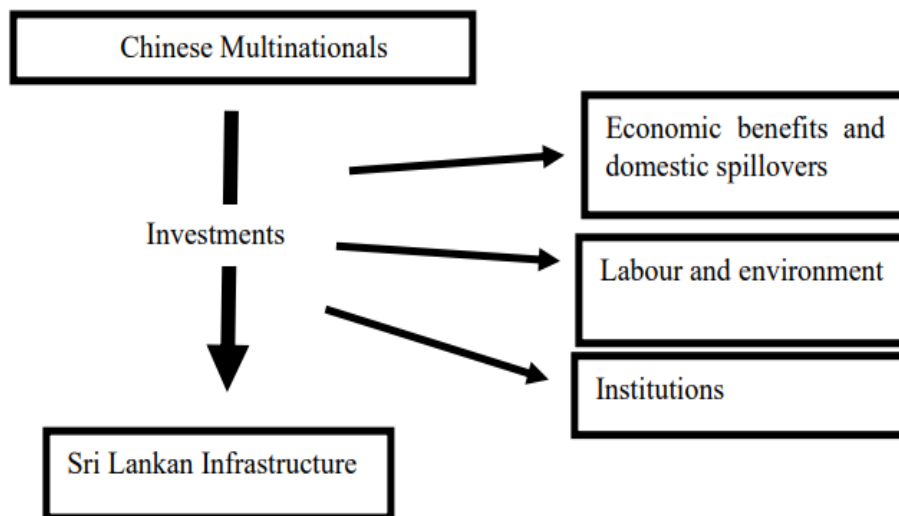


Figure 1: Theoretical framework

Source: Author's original work, 2022

Analysis

Infrastructure-related FDIs have implications for the Sri Lankan economy, labour, the environment, and institutions. China has invested in Sri Lankan infrastructure since the 1970s. Southern and Central expressways, Colombo port city urban development, Mattala International Airport, Norocholai power station, Hambantota port, Kandy North

Pathadumbara water supply project, Colombo International Container Terminal (CICT), and Lotus tower info and communication project are the giant infrastructure investments from Chinese MNEs. These Chinese infrastructure investments transmit technology and management practices to domestic firms which enhance their competitiveness and productivity (Wignaraja, et al., 2020). (Figure 2, Table 1)

Chinese Infrastructure Investments and Sri Lankan Economy

The cumulative amount of China's infrastructure investment in Sri Lanka from 2006 to July 2019 was USD 12.1 billion, which was 14% of Sri Lanka's GDP. There was only a slight increment from USD 5.4 billion in the 2006 to 2012 period, which accounted for about 15 projects. During the 2013 to 2019 period, there were 13 projects with USD 6.8 billion Chinese MNEs invested amount compared to the 2006 to 2012 period (Figure 2). However, Chinese infrastructure investments in Sri Lanka were around USD 12.1 billion between 2006 and July 2019. World bank report illustrated that Sri Lanka required USD \$36 billion to fulfill the current infrastructure gap. According to Chinese investment commitments, the estimated financing is USD 23.9 billion for current ongoing Chinese infrastructure investment (World Economic Forum, 2019; Wignaraja, et al., 2020; Global Competitiveness Report, 2019). Table 1 illustrates the Chinese infrastructure projects and economic benefits.

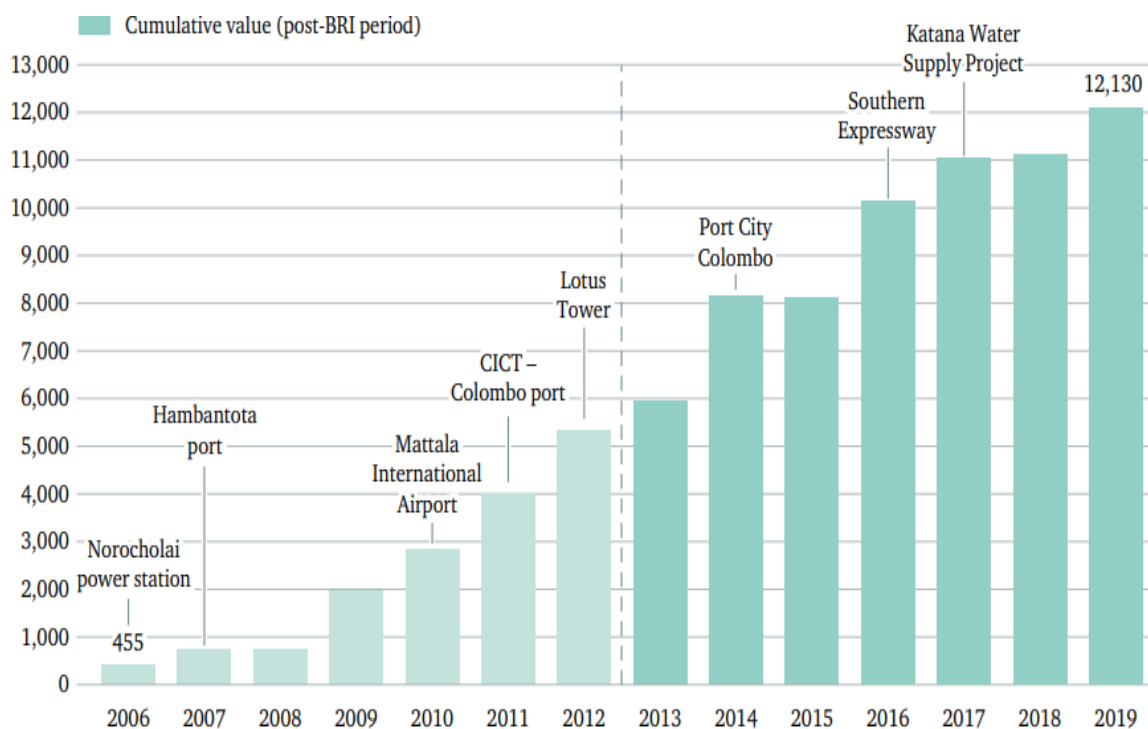


Figure 2: Infrastructure projects by China (\$ million)

Source: Wignaraja, et al., 2020

Table 1: The Chinese infrastructure projects and economic benefits

Project and current project status	Invested amount (\$ millions)	Implementing authority (Domestic authority/ firm)	Chinese investor (MNE)	Economic benefits
Southern Expressway (Ongoing- Partial open from Colombo to Matara. Matara to Hambantota is under construction.	1545	Road Development Authority	China Communication Construction Company Limited	<ul style="list-style-type: none"> • Reduce the travel time to Matara from Colombo from 6.5 hours to 3.5 hours. • Development in the hospitality industry on the southern coast. Specially in Hikkaduwa, Matara, Unawatuna and Hambantota area. • Tourist hotspot due to development of infrastructure.
Outer Circular Highway Project (Ongoing)	494	Road Development Authority	Metallurgical Corporation of China Limited.	<ul style="list-style-type: none"> • Linked Colombo-Matara, Colombo-Katunayake and proposed Colombo-Kandy expressways. • Easier to access all the expressways within few minutes.
Colombo Katunayake Expressway (Completed)	248	Road Development Authority	China Metallurgical Group Corporation	<ul style="list-style-type: none"> • Reduce the travel time to Katunayake airport from Central Colombo from 2 hours to 45 minutes.
Hambantota International Airport (Completed)	190	Airport and Aviation Lanka Limited	China Harbour Engineering Company	<ul style="list-style-type: none"> • Sri Lanka's second international airport and reduced congestion at Colombo airport. • Increased national passenger capacity. • Possible for an emergency landing.
Hambantota Port	1335.7 (Loan)	Sri Lankan Ports Authority	China Harbour Engineering	<ul style="list-style-type: none"> • Diversified its port

Development (Completed)			Company	operation from this project. <ul style="list-style-type: none"> • Addition value-added services. • Able to develop more primary industries from the industrial zone.
Colombo International Container Terminal (CICT) (Completed)	500	Sri Lankan Ports Authority	China Merchant Port Holdings	<ul style="list-style-type: none"> • South Asian deep-water terminal. • Outfitted with facilities to hold the greatest vessels afloat. • In 2018 this terminal connectivity with Drewry's port was the world's 11th best-connected port.
Norocholai power station (Completed)	1346 (Loan)	Ceylon Electricity Board (CEB)	China Machinery Engineering Corporation	<ul style="list-style-type: none"> • 31% of the capacity of CEB-owned power plants. • Generates 33% of Sri Lanka's total power.
Colombo Port City (Ongoing)	1300	N/A	China Harbour Engineering Company	<ul style="list-style-type: none"> • Project will create opportunities for 1.5 million A-Grade offices. • Will increase the business ranking and provide opportunities for new business. • Attract financial services.
Lotus Tower (Completed)	88.6	Telecommunications Regulatory Commission of Sri Lanka	China National Electronics Import and Export Corporation	<ul style="list-style-type: none"> • Enhance telecommunication infrastructure. • Provide leisure activities to the public. • Reduce the number of breakdown incidences.

Source: Author's Original Work, 2022 (Data collected from Board of Investment, Wignaraja, et al., 2020, Ministry of Finance – Sri Lanka)

Negative Implications on the Sri Lankan Economy from Chinese Infrastructure Investments

Domestic spillovers, the Chinese debt trap, and the trade deficit with China are the main negative implications of Chinese infrastructure investments. As discussed above Chinese FDIs have more positive domestic economic outcomes. There is a small drawback in sectoral shifts, exports, and employment. Chinese FDIs in the services and manufacturing sectors show a downward trend due to their dominant FDI on infrastructure. Further Board of Investment articulated that Chinese manufacturing and service firms support less than 1% when compared with other FDIs in Sri Lanka (Board of Investment of Sri Lanka, 2019).

There is a huge trade deficit between China and Sri Lanka. The capital goods and intermediate goods are imported from China for the expressways, urban development projects, and ports. Especially construction materials and road construction equipment are imported from China. Sri Lanka lacks capital goods for some industries. Sri Lanka imports more goods from China compared with exports goods to China. Therefore, there is a trade deficit. This trade deficit has negatively impacted the GDP and currency exchange rate of Sri Lanka (International Trade Centre, 2019; Wignaraja, et al., 2020).

Hambantota port was a Chinese investment with three fixed-interest loans from two Chinese state-owned enterprises and EXIM bank China. However, China Harbour Engineering Company incurred losses from this infrastructure investment due to a stain on Sri Lanka's public funds. As a result, Sri Lanka has plunged into the Chinese debt trap. Furthermore, the management of the Hambantota port was taken over by China Merchant Port Holdings Company Limited. Further, IMF reviewed that China has become a commercial loan provider for Sri Lankan infrastructure projects and it's USD 5 billion. However, Sri Lanka is facing a huge foreign debt issue. Total external public debt increased to USD 34.7 billion, and the debt service ratio increased to 15% in 2018 (Central Bank of Sri Lanka, 2019; Wignaraja, et al., 2020; Ministry of Finance, 2019; International Monetary Fund; 2019). Table 2 illustrates information about debt services and external public debt of Sri Lanka.

Table 2: External public debt and debt service of Sri Lanka

	2012	2015	2018
Total external public debt (a) – \$ billion	23.7	28.6	34.7
<i>Of which is held by:</i>			
China (b)	2.2	4.8	5.0
Japan	4.3	3.4	3.4
Other bilateral lenders (c)	3.3	2.3	2.2
Multilateral lenders (d)	6.6	7.3	7.9
Financial markets	7.0	10.8	16.2
Other (e)	0.3	0.1	0.1
External debt service to exports of goods & services (f)	12.3%	12.0%	15.0%
<i>Of which is held by:</i>			
China	0.8%	2.3%	2.5%
Japan	2.5%	1.3%	1.2%
Other bilateral lenders	1.7%	1.8%	2.5%
Multilateral lenders (World Bank, ADB etc.)	2.0%	1.9%	2.3%
Financial markets (g)	5.2%	4.8%	6.6%

Source: Wignaraja, et al., 2020

Labour and Environmental Impacts from Chinese Infrastructure Investments

Sunday Time Sri Lanka (2019) reported that Sri Lanka has 7,500 Chinese migrant workers. Further, illustrated that the Department of Immigration and Emigration has issued 6,504 residence visas for Chinese Nationals in 2018 due to these large-scale infrastructure development projects. The Colombo Port City has 1,637 skilled and unskilled workers including both local employees in construction, procurement, and engineering companies and Chinese employees from the parent company. CICT has 1350 and Hambantota port has about 900 migrant Chinese workers (Lanka Business Online, 2018; Wignaraja, et al., 2020).

The unskilled labour market in Sri Lanka and local workers gradually migrating abroad seeking better pay have resulted in local labour shortages in the construction sector. Somehow Chinese migrant workers were able to minimize the shortfall in the construction sector. Knowledge and skill transfers are the main benefits of Chinese migrant workers. Colombo Port City project will provide 122,000 job opportunities for local and foreign employees at the end of the project (Perera, 2018; Sri Lanka Bureau of Foreign Employment, 2011).

The Colombo Port City project and CICT have prioritized green technology. These projects have used electric cranes to reduce overall carbon dioxide emission levels and diesel consumption. Further, the Colombo Port City project maintains international green standard concepts. The project's sustainable master plan meets green mark standards and a green certificate from the Sri Lankan Building Council (CHEC Port City Colombo (Pvt) Ltd, 2017). The Norocholai power station has a negative environmental impact due to its coal power generation. It continuously damages the environment through carbon emissions. Kalpitiya peninsula, Wilpattu National Park, and marine life including dolphins and whales are infected

by carbon emissions from Norocholai. Sri Lanka Supreme Court has taken legal action against environmental pollution by this Norocholai infrastructure project. Further legal authorities encourage Chinese infrastructure projects to protect domestic environmental legislation and standards which have been expressed in ‘The National Environmental Protection Law of 1980’ (The Sunday Times Sri Lanka, 2019).

Institutions and Chinese Infrastructure Investment

The National Institutions of Sri Lanka should plan the projects by considering the scale of investment, available local resources, and stakeholders’ involvement. Accordingly, institutions should build public trust, combat corruption, and engage the public. The outcomes of these are beneficial for both countries to build a long-term economic relationship in the infrastructure (DailyFT, 2019).

Chinese public diplomacy encourages Chinese companies to CSR activities. CHEC spent USD 3 million for a CSR project which supported 9000 fishing families affected by the Port City project (CHEC Port City Colombo, 2019).

Conclusion and Recommendation

Knowledge and skill transfer to the local workers from Chinese migrant workers is a benefit for Sri Lankan labours. Colombo Port City project will provide 122,000 job opportunities for local and foreign employees at the end of the project. The Norocholai power station has a negative environmental impact due to its coal power generation. It continuously damages the environment through carbon emissions. CHEC spent USD 3 million for a CSR project which supported 9000 fishing families affected by the Port City project. Accordingly, the report revealed the positive and negative economic implications, positive impacts on labour market and negative impacts on the environment from Chinese infrastructure investments.

Appointing a proper committee to research the Sri Lankan treasury and debt. Implementing a strong debt management system may reduce debt-related vulnerabilities. Assistance from the world bank and international monetary funds and enhance debt management related to infrastructure investment may minimize the risk of Sri Lanka plunging into a Chinese debt trap in the future. Sri Lanka can also appeal for a moratorium on interest payments for a certain period for Chinese loans to accelerate overall debt sustainability (Kamardeen and Panditaratne, 2019; DailyFT, 2020).

Sri Lanka should encourage export-oriented FDIs from China to overcome the trade deficit. Sri Lanka can set up a well-resourced investment and export promotion office. Also, Sri Lanka should provide tax incentives for investment projects, streamline trade rules for investors and ensure a predictable macroeconomic environment (Wignaraja, et al., 2020). Encouraging Chinese and international investors in the manufacturing and service sector, enabling outward FDI related to the manufacturing and service sector, and creating linkages between infrastructure projects and local SMEs may influence positive domestic spillovers.

Sri Lanka should encourage green innovation, green technology, and green financing systems to reduce environmental pollution from infrastructure investments in the future. Also, recommends relevant Sri Lankan authorities for more national infrastructure projects to develop the country and build public trust in infrastructure investments.

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FACTORS INFLUENCE ON THE DEVELOPMENT OF SRI LANKAN NATURAL FOOD SUPPLY CHAIN

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Abstract

Sri Lankan natural food industry was severely affected by the effect of post Covid-19 pandemic and economic crisis. This study was focused to find the most impacting factors which develop the natural food supply chain in Sri Lanka. Collaboration, continuation, strategic orientation, risk management and proactivity were the factors tested in this study collecting 205 samples from the staff members who are currently involving throughout the natural food supply chain in different sections in Sri Lanka by using an especially designed online questionnaire. Results indicated that each tested factor has a positive relationship for the development of the natural food supply chain and the selected factors are responsible for the development of natural food supply chain in Sri Lanka as a percentage of 30.6%.

Keywords: Collaboration, Continuation, Development, Proactivity, Strategies, Natural food Supply Chain

Introduction

A food that includes 100% of natural ingredients defines as natural food which elongates in this study (Sandin, 2017). Agricultural production, handling after harvesting, processing & finishing, distribution, consumption and disposal are the main theoretical stages in a food supply chain. Different steps are involved in every stage which can positively or negatively affect on supply chain process. Therefore, to maximize the profit of a company or an organization by serving the best products to the consumers, it has become a must to address every steps involved in the whole supply chain(SC) process with sound developments. Development of the supply chain process is positively affecting in different manners to the food manufacturing industry. Improving customer service, reducing cost for material purchasing, improving the financial overall benefits and improving the quality of the life in the industry & the culture are some benefits of the development of the SC process.

Many food manufacturing companies in Sri Lanka are facing troubles when adapting to the current economic crisis which has happened due to the unstable political situation in Sri Lanka and a lot of companies have failed to achieve their objectives. National consumer price index has increased to 58.9% in June 2022 from 45.3% in May 2022 due to the inflation in Sri Lanka (Central Bank of Sri Lanka, 2022). This has driven the high increase in the prices of food and non-food products due to various cost increments relevant to complete the supply chains. Retaining fresh material suppliers to receive continuous supplies with agreed prices, controlling the processing steps in the production process according to global food safety standards and local food acts, achieving the planned profit margins and dealing with contacted agents for distribution with the agreed prices are some of the major challenges that

the Sri Lankan food manufacturing industry is currently facing. Hence the food supply chain process has become non continuous and the flow of the food supply chain process has become non continuous and irregular, due to aforementioned challenges. Many natural food-producing organization in Sri Lanka is facing disruptions due to post COVID-19 effect and inflation in both local and international markets. Natural food manufacturing industries are facing problems such as delays in procuring goods due to delays in supplying raw materials by the suppliers because of the fuel issues and payment issues, lack of logistic cargos as per the requirement, difficulty of controlling the price of quality raw materials and services with inventory shortage problems to continue the supply chain operations specially in South Asia as a result of post COVID-19 effect (Butt, 2021).

The objectives of the study are to identify influencing factors of the development of the food supply chain in the natural food manufacturing industry in Sri Lanka, to obtain the level of relationship between each influencing factors to the development of food supply chain in natural food manufacturing industry in Sri Lanka and to describe how the influencing factors numerically related to the development of food supply chain in natural food manufacturing industry in Sri Lanka.

Methodology

The answer for the research question in this study concludes through randomly selected set of people who are currently involving in the natural food manufacturing sector in Sri Lanka. All the information collected through the critical literature review including the identified major factors (Collaboration, continuation, strategic orientation, risk management and proactivity) were re-evaluated through a specifically designed questioner. This questionnaire was distributed among the staff level employees who are currently involved in the process of food supply chain in Sri Lanka. Questioner was designed by using relevant major indication factors which were found through the literature review. Complying level of quality standards (Wiengarten *et al.*, 2018), developed inventory management system (Cesarelli *et al.*, 2021) to develop the food supply chain, strong culture of the organization (Prasanna and Haavisto 2018) and current strategies (Dung, 2015) were the indicator factors of the collaboration. Properly managed continuations (Blos, Hoeflich and Miyagi, 2015) to indicate the continuation and green practices (Hsu *et al.*, 2015) to indicate strategic orientation were used. Well established preventive actions (Gouda and Saranga, 2018) to indicate risk management and properly handled and managed outsourcing contractors (Kim, 2003) were the indicators of proactivity. Only the key players in the natural food manufacturing industry have considered as the selected population/ Source population (sample size was 205 according to the Morgan chart). Finally collected set of factors which influence the development of food supply chain in natural food manufacturing industry in Sri Lanka will be concluded as the findings of this research as achievements of the objective of this study.

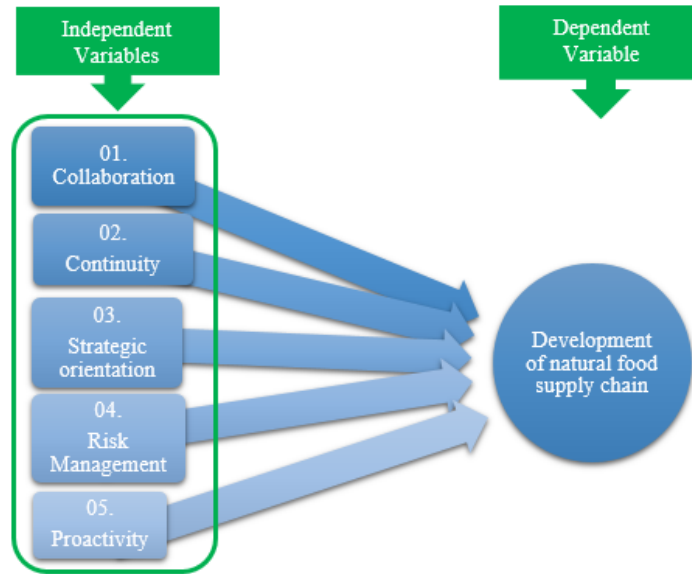


Figure 1- Conceptual framework

Target population of this study was the staff level employees currently work under different steps in Sri Lankan natural food supply chain. Approximately 440 were the count of staff level employees in the selected key playing companies in this study. Sample size was 205 according to the Morgan chart. Designed questionnaire was distributed through online platforms as in google form format to collect the real-time data for the analysis.

Results

Table:1 Study outcome

Factor Identified	Relationship	Results of hypotheses	Overall Model Fit
Collaboration	Weak positive relationship	Alternative hypothesis- Accepted Null hypothesis- Rejected	30.60%
Continuation	Weak positive relationship	Alternative hypothesis- Accepted Null hypothesis- Rejected	
Strategic Orientation	Weak positive relationship	Alternative hypothesis- Accepted Null hypothesis- Rejected	
Risk Management	Weak positive relationship	Alternative hypothesis- Accepted Null hypothesis- Rejected	
Proactivity	Weak positive relationship	Alternative hypothesis- Accepted Null hypothesis- Rejected	

Results obtained after the analysis were reflected that all the identified factors have weak positive relationships with the development of Sri Lankan natural supply chain and the model used for this study has a numerically 30.6% of fit for objective of this study.

Discussion & Conclusion

The study was conducted on finding the factors that influence the development of the food supply chain in natural food manufacturing industries in Sri Lanka and to find the impact of identified factors through the literature review on the natural food supply chain development. Base problem to conduct this study was the current crisis affected on the operations in natural food supply chains due to the economic crisis in Sri Lanka including the inflation and highly increased material prices, post COVID-19 effect and other economic issues from the buyer end (both local and foreign). The data analysis showed that collaboration (correlation value- 0.448) has a positive impact on the development of natural food supply chain in Sri Lankan food manufacturing industry, continuity (correlation value- 0.399) has a positive impact on the development of natural food supply chain in Sri Lankan food manufacturing industry, Strategic orientation (correlation value- 0.312) has a positive impact on the development of natural food supply chain in Sri Lankan food manufacturing industry, risk management (correlation value- 0.379) has a positive impact on the development of natural food supply chain in Sri Lankan food manufacturing industry and proactivity (correlation value- 0.364) positively impact on the development of natural food supply chain in Sri Lankan food manufacturing industry. Because all the correlation values obtained through the analysis results through SPSS software were between 0 to 0.5 at a significance values of 0.05. All the null hypotheses were rejected according to the analysis and according to the correlation analysis, it showed that there is a weak positive relationship between independent variables (Collaboration, Continuity, Strategic orientation, Risk management and Proactivity) and dependent variable (Development of natural food supply chain). 30.6% was resulted as the overall model fit with the predicted dependent variables which influence the development of natural food supply chain and can be concluded that there are more other factors which develops the natural food supply chain.

This study was helped to find that factors identified through the literature has a positive impact on the Sri Lankan contact specially under a crisis situation to be resistant as a company to develop their development of the supply chain. The selected target group of this study was an important decision in this study since they are the population who can share the best information in the current situation. Specifically, this study gives the necessary guidance to utilize the factors relevant to the development of the natural food supply chain overall process. And any interested party can conduct re-evaluations and research on specifically identified factors for better improvements as a further step of this study since this study conducts through the literature and experiences of experience employees in the natural food manufacturing field in Sri Lanka.

Recommendations

Although all the alternative hypotheses were accepted in this study, since it has showed a weak positive relationship between identified factors and the development of Sri Lankan natural food supply chain, it is recommended find more relevant specific factors which affect the development more by using only the actual situation in Sri Lankan natural food supply chain context. And it is recommended to implement different implementations towards sustaining the collaboration between all the involving stakeholders on the natural food supply chain in Sri Lanka, continuation of the existing processes in deferent internal and external conditions and situations, risk management plan towards mitigating the possible risks can be raised in future and proactivity of taking steps and decisions to achieve future targets and goals to achieve the overall sustainability in natural food manufacturing industry in Sri Lanka.

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CONSTRUCTION

COMPARISON OF COMPRESSIVE STRENGTH BETWEEN TWO POROUS CONCRETES BASED ON THE SIZE OF AGGREGATES USED

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Abstract

Porous concrete has become significantly popular during past recent decades, because of potential contribution in solving environmental issues. The use of porous concrete for the construction of pavement parking lots and driveways is becoming popular. One of the disadvantages of porous concrete is its lack of durability under heavy load due to low compressive strength. Therefore, it is necessary to analyse the performance of porous concrete to enhance its compressive strength. This research is aimed to develop and evaluate a comparison of compressive strength performance of porous concrete consisting of two types of aggregate sizes. In order to identify the variable in compressive strength, the aggregate to cement ratio will also be varied to obtain an optimum mixture for each type of porous concrete. Two sizes of crushed rock aggregate were selected (5-10mm and 10-14mm). As mix proportions, 0.25, 0.3, 0.35 and 0.4 water cement ratio were selected with 2.5 and 3.0 aggregate cement ratios. Experiments were conducted in two stages, stage one for compressive strength and stage two for aggregate property tests. Optimum compressive strength and porosity was observed with 2.5 A/C and 3.0 W/C for 10 – 14 mm aggregate size mix proportion (18.869 MPa). The optimum 5-10mm size mix proportions were 2.5 A/C and 0.35 W/C (17.922 MPa).

Keywords: Porous Concrete, Compressive Strength, Mix Proportion, Aggregate size, Water – Cement Ratio, Aggregate – Cement Ratio.

Introduction

Porous concrete is a composite material also known as the pervious concrete or permeable concrete. Porous concrete was developed as an environmentally healthy material in Japan in the 1980s (Bhutta, Tsuruta, & Mirza, 2012). Porous concrete consists of open-graded gravel or granite stone, cement and water and does not include sand or fine aggregates. This material differs from conventional concrete, due to the large void volume. Contemporarily, porous concrete is in demand in Europe, Japan and North America because of its many environmental benefits due to permeating, water discharge and water retention actions and thereby control storm water runoff, the restoration of soil water reserves and reducing water and soil pollution (Chi, Yieh, & Huang, 2014).

Among the various strategies for developing low impact on pavers, permeable concrete paving system has become a suitable candidate because of their structural, economic and road user benefits. However, a lower mechanical strength of porous concrete due to increased porosity, limits the application of porous concrete. However, applications are potentially suitable for the pavement of the parking lot, pedestrian walkway, and route of vehicles of low weight, low water crossings, tennis courts, slope stabilization and sub-base for conventional concrete pavements (Lian, Zhuge, & Beecham, 2011).

Traditionally sealing surfaces divert storm water runoff to sewer systems and waterways. Urbanization results in an increase in waterproof case, such as roofs, roads and paved surfaces and increased the cost of stormwater management systems. Porous concrete pavements have been developed as part of a series of Techniques that reduce runoff rates and volumes of urban areas. They attenuate the flash floods while retaining the hydrology of the developed area (Pratt, 1999).

Optimum compressive strength was observed to be obtained with a water/cement ratio of 0.3 – 0.35 while the lowest was observed for W/C ratio beyond that range (Schaefer C. , 1999) (Meininger, No fine pervious concrete fro paving , 1988). In addition, the optimum strength depends on several factors including, aggregate/cement ratio, water/cement ratio, particle shape, particle size distribution of aggregates, material type and compaction energy and method (Gafoori & Dutta, 1995) (Chindaprasirth, Effects of binder strength and aggregate size on the comperessive strength and void ratio of porous concrete , 2009) (Joshanghani, Ramezaniapour, & Jaberizadeh, 2014). This study focuses on the impact of aggregate size on the mix design of porous concrete.

Methodology

The experimental methodology for this research was aim examine the behavior of strength variation in porous concrete using different aggregate sizes. This study used three sizes of aggregates and different mix proportions varying aggregate - cement ratio (A/C) and water-cement ratio (W/C).

As the binding material ordinary Portland cement was used, which belongs to a strength class of 42.5N. It is in compliance with SLS 107:2015 Specification for Ordinary Portland Cement. The crushed rock was obtained from a quarry as coarse aggregate sizes between 3/8’’ (9.5mm) to 1/2’’ (12.7mm) and crushed rock chip aggregate (<10 mm). Aggregates were divided in to 3 size ranges G1, G2 & G3 (5 – 10mm and 10 – 14mm & 2.35 – 5mm) by using a sieve shaker. Trial tests were conducted for all three size groups and two groups were chosen for consequent studies based on the compressive strength (group 1: 5-10mm and group 2: 10-14 mm). By using 5 -10mm and 10 – 14mm aggregate sizes experimental stage tests were conducted.

Table 1 illustrate the mix proportion contents including W/C and A/C.

Table 1: Module 1 Mix Proportions

Mix Proportion		Aggregate Size
Water: Cement	Aggregate: Cement	
0.25	2.5	G1 (5-10 mm) & G2 (10 – 14 mm)
0.30		
0.35		
0.40		
0.25	3.0	G1 (5-10 mm) & G2 (10 – 14 mm)
0.30		
0.35		
0.40		

According to BS1881: Part 116: 1983, the compressive strength of cured concrete cubes were tested. Three cubes for each mix were evaluated using a Universal Testing Machine for compressive strength after curing for 7 and 28 days. A loading rate of 1mm/min was used to applied the axial load.

Results and Discussion

Figure 01 illustrates the variation of compressive strength in 7 days curing, mix proportion of 5 -10 mm and 10 -14mm size aggregate ranges by using both 2.5 and 3.0 A/C mix ratio.

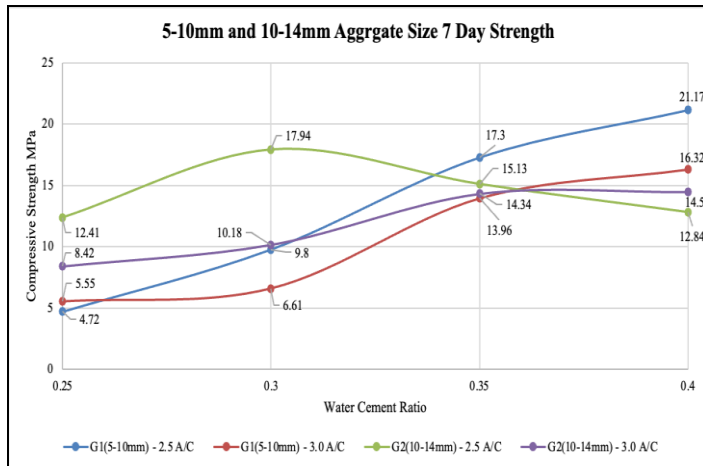


Figure 1: G1 and G2 compressive strength 7 days

The highest compressive strength (21.17 MPa) is recorded by the G1 (5-10mm) aggregate size range within seven days curing, mix proportion of 2.5 A/C and 0.4 W/C. Also, the least compressive strength (4.72 MPa) was provided by 2.5 A/C and 0.25 W/C mix proportion. However, according to the strength variation can observe in the 0.25 W/C stage, the variation is different. Thus, 3.0 A/C shows higher compressive strength than 2.5 A/C mix proportion. In all other mixes 2.5 A/C mix proportion shows compressive strength higher than 3.0 A/C mix proportions.

In the mix of 0.3 W/C and 2.5 A/C, water content is more considerable than in the previous stages. It seems help to improve the cement hydration process than the previous stages. The test cube visually with good strength and particle bonding was also in a higher position. Nevertheless, theoretically, 0.42 water to cement ratio is needed for better hydration (Aitcin & Flatt, 2016).

However, considering the concrete mix's porosity, there is a lack of voids observed in the surface and the core of the specimen with the 0.4 W/C G1 size range test specimens.

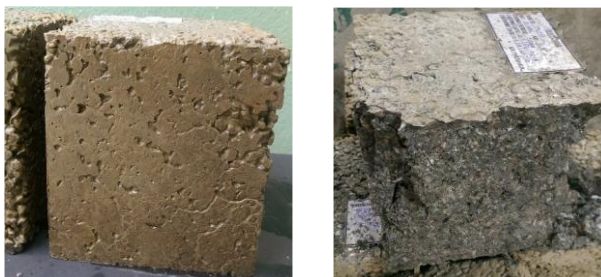


Figure 2: G1 - 0.4 W/C test specimen

The strength variations of the G2 (10 -14mm) size aggregate shows different patterns than the 5 - 10 mm aggregate size. The graph shows the highest strength recorded from mix proportion 2.5 A/C and 0.3 W/C. Instead, 3.0 aggregate - cement ratio patterns show higher strength with a 0.35 W/C ratio. However, the most suitable and highest strength mix proportion was 2.5 A/C and 0.30 W/C.

In 0.25 water-cement stages, there is less water. However, compared to the 5 - 10 mm size at this stage, 10 -14 mm is in good condition. It takes more strength than 5 -10 mm test specimens. 2.5 A/C mix proportion is with higher cement content than the 3.0 A/C ratio. In this size, the range can visually see that cement paste act like a cover of an aggregate practical. Also, 2.5 A/C has a thicker cement paste cover than 3.0 A/C. Maybe that was a reason to get the higher strength of the 2.5 aggregate cement mix proportion.

0.3 W/C with 2.5 A/C is the mix that recorded the highest strength in G2 (10-14mm) size range in 7 days curing (17.94 MPa). However, the porosity is there with enough condition for the paving system. Pore spaces are not much larger than 0.25 W/C proportion cubes.

In the 0.35 water-cement stage, the mix proportion had higher workability. However, the strength is getting lower in the 2.5 A/C and also 3.0 A/C mix proportion. All test specimens of cement were sunk to the bottom of the cube, and a small cement paste remained with the aggregate particles at the top of the cube.

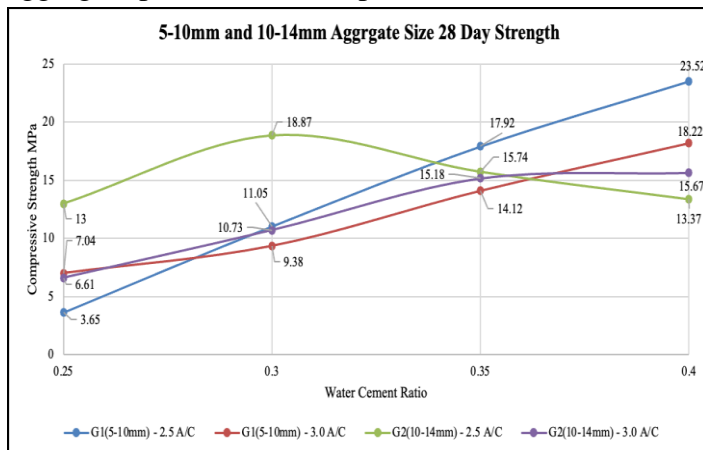


Figure 3: G1 and G2 compressive strength 28 days

As evidence in figure 3, the strength of G1 (5-10 mm) and G2 (10 - 14 mm) aggregate size ranges in 28 days curing as follows the 7 days curing strength pattern and increased strength. As indeed highest strength recorded by mix proportion 0.40 water to cement with 2.5 aggregate-cement ratio and it is an 11.4% strength increment. However, consider the practicability and porosity capability, G2 (10-14mm) size range 2.5 A/C and 0.3 W/C will be the best option for applications. Further, strength has been increased by 5.2% compared to the 7 days.

The highest strength recorded by the G1 (5-10 mm) size range mix proportion of 2.5 A/C and 0.35 W/C was 17.92 MPa following the same pattern of 7 days curing, and it is an increment of 3.6%.

Conclusion

Porous concrete has become significantly popular during recent decades, because of its potential contribution on in solving environmental issues. Porous concrete is a type of concrete with significantly high-water permeability compared to the normal concrete. Unfortunately, there is not a precise recipe for porous concrete that will yield a high compressive strength. Therefore, this research was mainly focused on the compressive strength, the increased variability of porous concrete strength properties were attributed to the variation in compressive strength

To examine the behavior of strength variation in porous concrete using different aggregate size, tests was conducted for both 5 -10mm and 10-14mm aggregates.

As per the obtained results, it can conclude that suitable water -cement ratio range for small aggregates (5 -10mm) 0.25 – 0.35 and for large aggregates (10 -14mm) within range 0.25 - 0.3. In porous concrete, cement acts like a paste that covers each particle. If consider the 10 - 14mm size aggregates it clearly shows the cement paste thickness affection for the compressive strength. Properly hydrated higher cement paste thickness provide higher compressive strength to the test specimen. Also, 5 – 10mm aggregate test results is higher with the higher cement content but need sufficient water content for appropriate hydration.

Therefore, it can conclude the higher cement content with appropriate water content (greater than 0.25 W/C) will show the higher compressive strength. Hence, the most suitable aggregate-cement ratio for porous concrete according to the research is 2.5. According to the revealed results and observations, the most suitable porous concrete mix proportion can be concluded for 5-10 mm size aggregate range is 2.5 A/C and 0.35 W/C. Same as the 10 - 14mm aggregate size is 2.5 A/C and 0.3 W/C mix proportion. These mix proportions are experimentally and practically suitable for porous pavements. Also, highest compressive strength recorded by 10 -14mm aggregate size with 2.5 A/C and 3.0 W/C.

Further, research can develop to identify the effects of permeability, compaction energy, particle packing and texture on performance of porous concrete.

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COMPARISON OF COMPRESSIVE STRENGTH OF POROUS CONCRETE BASED ON DIFFERENT MIXTURE OF AGGREGATE SIZES

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Abstract

This research investigated the effects of material composition of different mixtures of aggregates substitution with smaller aggregate on the compressive strength of porous concrete, in an effort to increase the compressive strength. Using three different coarse aggregate gradations, 2.36- 5mm, 5-10mm and 10-14mm, fifteen different concrete mixtures were cast mixing two aggregate gradations with substitution of smaller aggregate in which the aggregate: cement and water: cement ratio were held constant, while concrete aspects investigated include slump as well as compressive strength after curing periods of 7 and 28 days. Test results show that coarse aggregate properties often have a significant effect on the mechanical properties of porous concrete. Every mixture was reached their highest compressive strength when the substitution increased up to 40% and mixture 01 (2.36-5mm and 5-10mm), mixture 03 (5-10mm and 10-14mm) both were increased their strength in similar pattern with against of substitutions of smaller aggregate and mixture 02 (2.36-5mm and 10-14mm) showed significantly less improvement in compressive strength compared to other two mixtures. However, realize that for both cured period and for every substitution the highest compressive strength could obtain by using the mixture 03 (5-10mm and 10-14mm) with the optimum value of 24.07 kPa. It is shown that using a mixture of two coarse aggregate will influence the compressive strength of porous concrete.

Keywords: Porous Concrete, Compressive Strength, Mix Proportion, Aggregate size, Water – Cement Ratio, Aggregate – Cement Ratio.

Introduction

Porous pavement is an emerging alternative in pavement design. This is a sustainable urban drainage system which has been developed to reduce the runoff flow rates and volumes to control flooding. Porous pavement method is a unique and effective method to meet growing environmental needs, since rapid urbanization and expanding cities resulted in the increase in impermeable surfaces such as highways and paved surfaces.

Environmental benefits and stormwater management are evident through the proper use of porous concrete (Delatte & Schwartz, 2010).

Its matrix is composed of intentionally interconnected voids (Chandaprasirt, 2008). Due to the high porosity, typically varying from 15%-25%, water is allowed to infiltrate through the pavement structure, leading to a reduction in stormwater run-off volume and recharge of the ground water table (Tennis, Leming, & Akers, 2004). Porous concrete, with its high albedo and low

thermal mass, further has environmental advantages in terms of reducing the heat island effect (Delatte & Schwartz, 2010).

A concrete pavement application requires compressive strength usually ranging from 28kPa to 20kPa (Kosmatka, Kerkhoff, & Panarese, 2008) and compressive strength of porous concrete is in the range from 5MPa to 20MPa (Tennis, Leming, & Akers, 2004). Contemporarily, porous concrete is specifically limited in its applications to public squares, pedestrian paths and parking lots due to the compromised structural strength and not used in higher traffic volume road ways (Yang & Jiang, 2003).

Therefore, this study focuses on the compressive strength of porous concrete using different sizes of aggregate for the mix design of porous concrete.

Methodology

The experimental methodology for this research was aim examine the behavior of strength variation in porous concrete

using different mixtures of aggregates substitution with smaller aggregate on the compressive strength of porous concrete to increase the compressive strength. The porous concrete mixtures were cast, mixing two aggregates. Gradations with substitution of smaller aggregate in which the aggregate: cement (2.5) and water: cement ratio (0.3) were held constant.

As the binding material ordinary Portland cement was used, which belongs to a strength class of 42.5N. It is in compliance with SLS 107:2015 Specification for ordinary Portland cement. Three control mixtures corresponding to three aggregate sizes were proportioned (2-35 – 5mm, 5mm – 10mm and 10mm - 14mm). When casting the concrete, zero fines were used to increase porosity of the concrete pavement. Therefore, three different aggregate sizes were sieved and separated. Accordingly, the mixture of different two aggregate sizes, small aggregate size proportion was varied with 0%, 10%, 20%, 30%, 40% and 50%. The reference mixtures were re-proportioned for a constant volume.

Table 1: Module 2 Mix Proportions

Aggregate Group	Aggregate Size Range	Water: Cement	Aggregate: Cement
Mix 1	G1 (5-10mm) + G3 (2.35-5mm)	0.3	2.5
Mix 2	G2 (10-14mm) + G3 (2.35-5mm)		
Mix 3	G2 (10-14mm) + G2 (5-10 mm)		

Eighteen different porous concrete designs were examined. These designs included control cubes for each mixture. These control cubes were cast only 100% of large aggregate size in the particular mixture. From these control cubes were used to obtain the aggregate and material quality control of construction testing. The compressive stress of the test specimen was determined by according to BS1881: Part 116: 1983. Compressive stress machine was used to test compressive stress. The test machine used was hydraulically powered and maintaining loading rate in between 0 and 1mm/min.

Results and Discussion

Figure 1 shows the variation of average compressive strength of aggregate mix 1, 2 & 3.

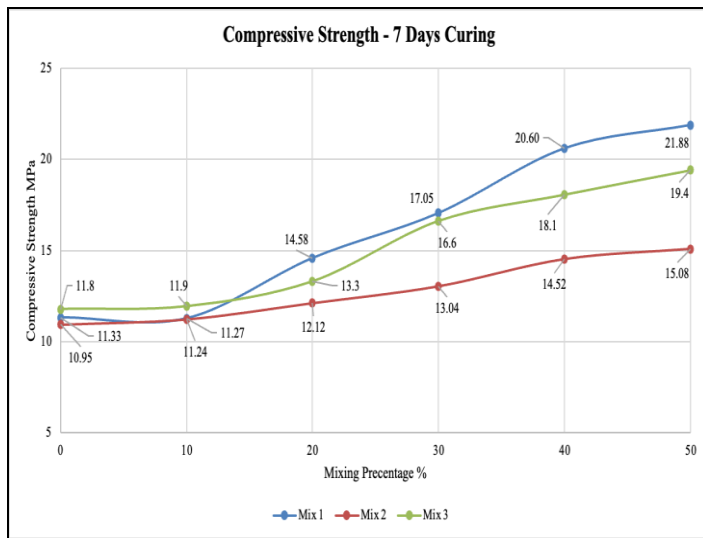


Figure 1: Compressive strength variation - 7 days curing

The optimum compressive strength of 21.88 MPa was recorded by mix 1 (5-10mm + 2.35-5mm) with the 50% mixing percentage of a small aggregate range. The lowest compressive strength was 10.95 MPa recorded by Mix 2 (10-14 mm + 2.35-5mm) at 10%. Further, it is evident that Mix 2 and Mix 3 proportions also shows the optimum at 50% mixing percentage.

It can conclude that when the content of small particles getting increased, the compressive strength gradually increases. It can be observed that compressive strength was gradually increased while mixing more G3 aggregates with G1 aggregates due to the increase in the contact area as the aggregate size is reduced. More importantly, the cohesive agent and cement hydration products co-mingle and create two interpenetrating materials which work together, resulting in improved strength.

On the other hand, mixing small two aggregates have less space between aggregate particles. The concrete mix allows a greater contact area between the paste coatings on individual aggregate particles, decreasing the voids space and lowering the amount of paste or mortar required to fill the spaces. The smaller particles with angular and flaky shapes are well bonded into the mortar and fractured in compression or indirect tension along the failure plane. Therefore, using a mixture of two smaller coarse aggregate (or a broader range of aggregate sizes) will influence the compressive strength of porous concrete more than the use of a mixture of single aggregate.

Mixing of two aggregate gradations such as G2 (10-14mm) and G3 (2.35-5mm), while increasing G3 (2.35-5mm) mixing percentage porous concrete shows a significant increase. While mixing those two aggregate gradations, the angularity number was increased. When the angularity number increases, the ratio of voids present in the aggregate also increases. Concepts of angularity number, the total void present in the aggregate are determined for all the mixtures along with G3 (2.35-5mm) aggregate. Further, the increase of G3 (2.35-5mm)

aggregate decreases the total void. It can be due to the increase in the contact area, which increases as the aggregate size is reduced.

The voids left by larger coarse aggregate particles are filled by smaller coarse aggregate particles and filled. This way, the volume of mortar (cement-water paste) required to fill the final voids is minimum. However, in some cases, well-graded aggregate can be used where some intermediate size is used. The use of well-graded aggregate may have an adverse effect on strength. By proper mixing grading of coarse aggregate, the possibility of segregation is minimized, especially for higher compressive strength.

Inter-aggregate bonding is critical for the strength of porous concrete, and the strength of porous concrete is strongly dependent on the thickness of paste layers coating the aggregate particles. The paste coating thickness is directly dependent on the G3 (2.35-5mm) aggregate content. The strength developed by this concrete is proportional to the inherent strength of the aggregate, the strength of the cement binder and the bond developed between binder and aggregate. The void spaces contribute nothing to the development of strength. Voids also contribute no weight to the concrete and the relationship between strength and weight.

Larger aggregate will produce larger voids, but excess paste will partially fill in the voids since the aggregate has less surface area per volume for the cement paste to stick. Therefore, using a mixture of aggregate will influence the compressive strength of porous concrete more than the use of a mixture of single aggregate.

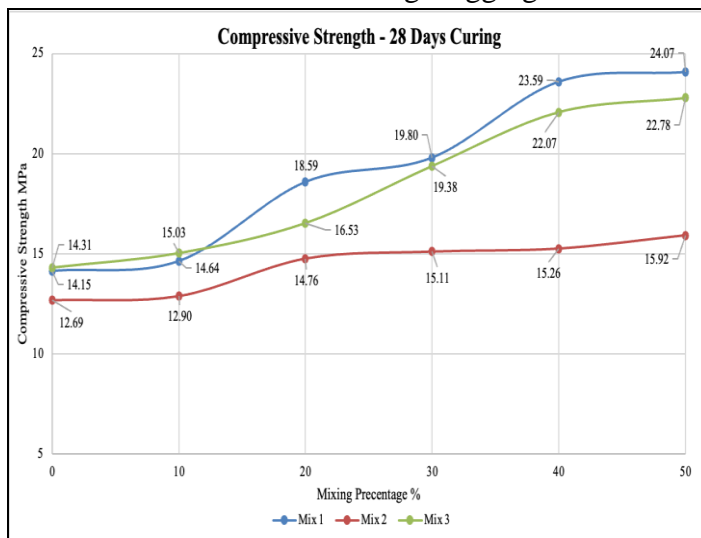


Figure 2: Compressive strength variation – 28 days curing

Figure 2 shows the compressive strength values of 28 days curing days.

Every proportion mix 1, 2 and 3 reached their highest compressive strength when the substitution increased up to 50% which were 24.07MPa, 15.92MPa and 22.78MPa respectively. Although all mixtures showed significant improvement in compressive strength, mixture 02 that had a gap of particle size showed significantly less improvement in compressive strength compared to other two mixtures that had substitution of continuous sizes (without a gap of particle sizes).

Conclusions

To examine the effects of the material composition of different mixtures of aggregates substitution with smaller aggregate on the compressive strength of porous concrete to increase the compressive strength. Test carried out using aggregate size ranges 2.36-5mm (G3), 5-10mm (G1) and 10-14mm (G2) were selected in concrete preparation procedure. Since the main objective of this research is to prepare no fines concrete with optimum porosity, above mentioned size ranges of aggregates were selected instead of using river sand. Because if sand was used to prepare the desired concrete mixture, the bond between aggregate particles in the concrete and the cement paste will be maximum. But by mixing above mentioned aggregate ranges, the requirement of the using sand can be omitted by using aggregates of smaller size without compromising the porosity of the concrete mixture.

The compressive strength of all mixtures was significantly increased with the substitution of smaller aggregates with different percentages. The variation in compressive strength of the cubes with no substitution and 10% substitution were not significant as the variation of compressive strength between the cubes with 20%, 30%, 40% & 50% substitution and no substitution, all mixtures. And similar values indicate that the compressive strength of control cubes during the test period that the influence of other environmental factors may be negligible.

Therefore, no change was observed in the compressive strength test cubes that can be attributed to the variation of mixing smaller aggregate. Therefore, it is necessary to understand the impact of the smaller aggregate mixture strength test cubes using a graphical tool. Although all mixtures showed significant improvement in compressive strength, mixture containing 2.36-5mm aggregates and 10-14mm aggregate, that had a gap of particle size showed significantly less improvement in compressive strength compared to other two mixtures that had substitution of continuous sizes. Every mixture reached their highest compressive strength when the substitution increased up to 40% and mix 1 (2.36-5mm and 5-10mm), mix 03 (5-10mm and 10-14mm) both were increased their strength in similar pattern with against of substitutions of smaller aggregate. However, it is realized that for both curing period and for every substitution the highest compressive strength could be obtained by using the mix 3 (5-10mm and 10-14mm) with the value of 22.78Mpa.

Through the results, it can be seen that the porous concrete mixture that resulted in the higher compressive strength, did not correlate to the paste with the highest compressive strength. Therefore, using a mixture of two coarse aggregate (or a broader range of aggregate sizes) will influence the compressive strength of porous concrete more than the use of mixture of single aggregate. From the whole experiment results the significant fact which illustrated was that the continuous size of aggregate mixtures showed the highest compressive strength compared to other mixture. Simply it means the mix 1 (2.36-5mm and 5-10mm) and mix 03 (5-10mm and 10-14mm) showed a considerably higher compressive strength compared to the mix 2 which contained aggregate size (2.36-5mm and 10-14mm).

Further, research can develop to identify the effects of permeability, compaction energy, particle packing and texture on performance of porous concrete.

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INVESTIGATION OF THE EFFECT OF PINE CONE DUST AS A RETAINING LAYER IN EMBANKMENT CONSTRUCTION

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Abstract

Mud soil would commonly notice during roadway construction in sensitive ecological zones. A layer of pine cone dust (PCD) is utilized as a retaining material to improve the stability of mud soil in the construction of embankments in muddy locations. In this investigation, PCD was added in layers at 14% and 4% to decrease the negative pore pressure (NPP) generated by mud soil. The NPP was decreased from both the samples and 7.82% and 6.25% of the water emptied respectively. The coefficient of permeability value (K) of these samples remained at 10^{-5} . And since this unattended cannot maintain the soil stable, the amount of chemicals added to the soil properties has been limited by using lime instead of Portland cement. Furthermore, highest pH level has been obtained by the 4% of PCD sample. The primary purpose is to utilize PCD as a solution for decrease the NPP and obtained the sustainability. According to cost analysis, the use of PCD can be done at a lower cost than other methods used to stabilize the soil, where 14% of the use of PCD sample evaluates the lowest cost.

Key Words: Pine cone dust, Mud soil, Water retaining layer, Negative Pore pressure, Permeability.

Introduction

The objective of operating Pine Cone Dust (PCD) for embankment construction is to experiment with how prosperous the use of PCD combined with the mud soil properties for improve then soil. It is essential to realize the unique property of PCD which has water retention and slow decomposition. The application of PCD will retain water and strengthen the mud soil. These literature reviews have been referred for the approach. A well-reinforced experimental embankment was constructed on peat soil for a highway construction project in Sri Lanka (Karunawardena, n.d.) and the Stability of three meters and mining applications is studied considering the effects of NPP formation and distribution (Ghadrdan, 2019). For laboratory tests, one sample as (Mud 20%, Lime 6%, PCD 14%, Soil 60%), and another sample as (Mud 20%, Lime 4%, PCD 4%, Soil 70%) are used for testing. Variations in water-saturation in soil during periods of intense rainfall have been examined (Nanthini Vasanthan, 2015). Water saturation during periods of heavy rains can generate embankment failure. This point is taken into interpretation and the two specimens can be observed through a prototype. This research expects to use lime and PCD and decrease the initial cost for significant benefit to the development of the construction.

Aim & Objectives

The essential concern of this investigation is to relive whether PCD can be used to stabilize mud soils and act as a water retention layer to reduce capillarity and NPP.

- To identify a required layer to check the displacement of the embankment using PCD. Presenting two samples as (Mud soil 20%, Lime 6%, PCD 14%, (foods, n.d.) Soil 60%) and (Mud 20%, Lime 6%, PCD 4%, Soil 70%) respectively.
- To examine the amount of water penetrating through the soil and density displacement in the embankment.
- To observe whether the NPP can be decreases on the saturated mud soil layer and monitor the rate of water removal in the saturated pine layer.
- To evaluate whether sustainable development can be achieved by reducing the cost of engineered soil and decline Portland cement usage.

Methodology

Improved PCD layers are used in two samples to examine variations in pore water pressure. Fallen Pine cones are selected within the period of September to October and have been air dried approximately 24 hours before to the crushing. 4.75mm sieved particles were used for the testings. Several factors should be taken into account when designing (Table 1). Such as, add 4% lime to the soil to maintain stability and preserve the pH level in 12 (Zukri, n.d.) and 2% of lime is added to 20% of mud soil to maintain the stability (V. K. Stalin, n.d.).

Table 1: Mix proportions

Samples	Soil %	Lime (Upper) %	Pine cone dust %	Lime (Bottom) %	Mud Soil %
S1	60	4	14	2	20
S2	70	4	4	2	20

The safety factor can be reduced by up to 60% (Development, 2009). PCD should be limited to 14% & 4% respectively. Organic matter such as peat has poor engineering-properties. Coefficient of permeability in peat is 10^{-7} m/s (Karunawardena, n.d.). Considering whether the PCD is lower or higher than this value, can be determined. Samples were experimented with beneath a prototype and allowed to settle under 1125 g of soil layer weight for three days to inspect that the NPP induced by the mud. Obtained mud is dewatered by oven method under 100°C for 24 hours and the weight of the samples has been resembled. The quantity of water that pours when the PCD layer is saturated with water was also tested.

The model should be conceived in such a method that the outlet is beyond the mud sample. The justification is that in demand for proceeding with construction work without extracting the mud, the prototype is essential to regard the mud soil and is challenging to experiment with the impact of NPP without isolating the mud sample. Material rate of 2022 can be evaluated a proper cost analysis to find whether the research achieved sustainability by reducing the cost. A specific pH level of 12.4 should be maintained to induce a long-term reaction. pH meter can determine whether the required pH value achieved (Highways, 2018).

Results and Discussion

Permeability

The falling head permeability test was conducted twice for each sample, which demonstrates the data obtained below (Table 2).

Table 2: Permeability Test Results

Item	Trial 1		Trial 2	
Samples	S1	S2	S1	S2
Diameter of specimen, D (cm)	10	10	10	10
Length of specimen, (cm)	11	11	11	11
Area of specimen, A (cm ²)	78.57	78.57	78.57	78.57
Area of standpipe, a (cm ²)	4.15	4.15	4.15	4.15
Beginning head h ₁ , (cm)	100	100	100	100
Ending head h ₂ , (cm)	4	10.5	18.2	37
Duration (min)	5	6	2	3
K (m/s)	10 ⁻⁵	10 ⁻⁵	10 ⁻⁵	10 ⁻⁵

The two samplings were subjected to the falling head test to examine the permeability and the significance obtained according to Darcy's law and the K factor was $K = 10^{-5}$. K value is in the Rapid and Moderate range and it is evident that the samples are more diminutive draw than the significance obtained for materials such as peat ($K = 10^{-7}$).

Negative Pour Pressure and water retention

Pursuing are the data acquired after three days of placing the samplings into the prototype (Table 3). This encloses the quantity of water drained from the samples, the quantity of water drained in the mud soil samples, and the quantity of water retained by PCD. The initial 2L water quantity has been counted with 1125g of precise weight. Regarding the oven-dried method, the saturated water in a specific quantity of mud soil was encountered as 20g.

Table 3: NPP testing details of the samples

Samples	Drain (g)	Retaining (g)	Drain in mud soil (g)	Settlement (mm)
S1	10.82%	2.44%	7.82%	0.06
S2	17.47%	21.42%	6.25%	2.04
Conventional	24.70%	-	9.37%	2.37



Figure 1: Sample 1 testing (S1)



Figure 2: Sample 1 (S1)

The data conveyed after the specimen including 14% PCD was allowed to settle for three days and showed that 10.82% of water was drained from the S1 (Figure 1). At the time of removal of the sample (Figure 2), the PCD layer was potent and performed as a barrier between the mud layer and the soil layer. The quantity of water in the layers can be specified by keeping the 100°C of temperature by operating the oven-dried method and taking from each sample weighing after 24 hours (Figure 3). The PCD layer absorbed only 2.44% of water.



Figure 3: After oven-dried method

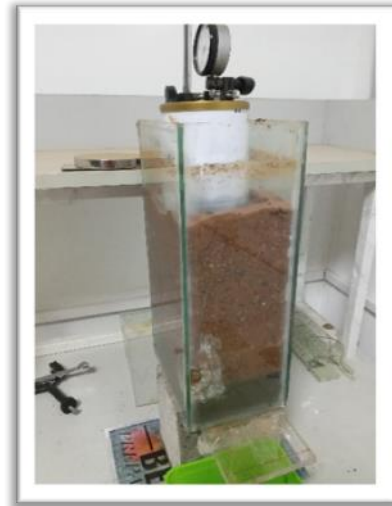


Figure 4: Conventional sample testing

The sample of 4% PCD was obeyed after three days, and 17.47% of the water had been released and retained 21.42% of water. S2 has controlled more water than S1, because a diminutive quantity of PCD has been counted. Correspondingly, 24.7% of the water was drained after three days in the conventional sample (Figure 4). Settlement possibilities were more predominant in the conventional sample and had a value of 2.37mm.



Figure 5: Sample 1 (S1)



Figure 6: Conventional sample

When investigating the mud samples obtained after three days of these models, conceivable to distinguish that 7.82% of water was removed from S1 (Figure 5), 6.25% from S2 and 9.37% from the conventional sample (Figure 6). A significant observation is that the water can only be released from the isolated mud sample by engaging NPP. Because the NPP in the conventional sample does not change. The mud sample is rapidly saturated with water from the soil sampler, thereby draining happens. Therefore, PCD decreases NPP by both S1 and S2.

Cost Analysis

The year of 2021 data has been acquired because non-of the highway construction work was done in the contribution of 2022. Only the expenses of raw materials are contained in recent values and the characteristics regarding the cost analysis (Table 4), have been specially brought into consideration (HRS-2021North Western Province).

Table 4: Cost analysis details

Item	Cement Stabilization (Rs. per m ³)	Lime Stabilization (Rs. per m ³)	Sample 1(Rs. per m ³)	Sample 2(Rs. per m ³)
Excavation Loose soil (wet)	722.10	722.10	-	-
Approved soil spread & rolled including hire charges, fuel & watering (loose volume)	406.5	406.5	406.5	406.5
Red Soil	8,400 (70%)	10,200 (85%)	7,200 (60%)	8,400 (70%)
Cement	27,900 (30%)	-	-	-
Lime	-	11,200 (15%)	4,480 (6%)	4,480 (6%)
Pine Cone Dust	-	-	-	-
Total	37,428.3	22,528.5	12,086.5	13,286.5

Cement and lime are used for stabilization at 30% and 15% respectively (Aytekin, 1998). As per the (HRS)-2021 information and segments that are efficiently subject to financial modifications are included in the results and the prices of raw materials in 2022 are as follows (Table 5). S1 can be accomplished at the lowest expense (Rs. 12,086.5 per 1m³).

Table 5: Raw material expenses

Item	Quantity	Price in 2022 (Rs.)
Red Soil	1m ³	12,000.00
Cement	1 Bag	3,100.00
Lime	1 Bag	560.00

pH Test

The data of the pH tests executed individually under 50ml equivalent volumes of the two samples are as observed.

Table 6: pH test details

Samples	Weight (g)	Volume (ml)	pH
S1	10.0375	50	10.07
S2	10.0237	50	11.14

The pH values of the S1 and S2 were discovered to be the pH level of 10.04 and 11.14 respectively (Table 6). Since the first sample and the second sample are closer to pH

12.4, both samples can be considered that a long-term reaction ensues. The second sample demonstrates higher results.

Conclusion

For the investigation, a well-graded soil with ($C_u = 25.25$) and ($C_c = 1$) was used for obtained the results. Samples with 14% and 4% PCD in the substitutes were tested for three days to acquire data significantly. In this examination,

- Encountered from both samples that the coefficient of permeability (K) was 10^{-5} and it is in the Rapid and moderate range.
- The PCD used both samples under reduced NPP, out of which the 14% sample remained more durable. But the 4% sample drained less amount of water.
- S2 retained more water and it was evident that the mud from the S2 drained 6.25% and 7.82% of water in S1.
- The pH value of S2 was 11.014. It was evident that S2 had higher reactivity.
- The most advantageous compound was S1. The amount was 12,086.5 Rs/ m^3 and only variable components were obtained by (HRS-1) data to acquire that data. The details on raw materials are exclusively the prices for the year 2022.
- The shear strength of the samples were not concerned in this examination and additional investigation is required.

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DEVELOPMENT OF PHYSICAL PROPERTIES OF WASTE PAPER COMPOSITE CEILING BOARD REINFORCED BY HANA FIBERS

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Abstract

The current and future shortage of materials will have severe impact on the construction industry and ceiling panels are an essential part of the building construction industry. An attempt has been made here to find a solution for this by using waste paper and locally available Hana fibers. The analysis of the information obtained from the variation of the mixture ratios by volume percentage of Cement, Paper and Fibers and they are sample A – 45%:45%:10%, B – 50%:40%:10%, C – 60%:30%:10%, D - 70%:20%:10%, and E - 80%:10%:10% were tested for flexural strength, water absorption, thermal resistance and observations are made based on the results and analyzed comparing to the existing Asbestos ceiling sheets' respective parameters. Significant improvement in physical properties were detected. And as the paper volume ratio increases, it appears that the thermal resistance increases. Finally, the sample C (60% Cement / 30% Paper/ 10%Fiber V/V & cured for 14-days) is found as the best mix design based on mechanical properties and on economic aspects.

Key Words: Ceiling Boards, Reinforced, Hana Fibers

Introduction

Every year in Sri Lanka, the use of paper increases and the recycling of discarded paper is very low. Newspapers are suitable for this as they were previously used for the production of food items, but according to the new laws and regulations, it was stopped (The Government Official News Portal, 2000). Therefore, discarded newspapers were reused in ceiling board manufacture here in this study.

Also, the Hana plants (Figure: 1), which grows under the natural environmental conditions in Sri Lanka is found as a good sustainable material. This study is carried out aiming to produce an eco-friendly, affordable, ceiling board by waste disposable paper and reinforced by locally available Hana fibers as a solution to the current and future elements shortage and to develop the conventional physical properties in ceiling sheets.



Figure 1: Hana plants.

In literature reviewing, it is found the methods of mixing paper with cement have been studied by Ataguba, C. and Oguche, 2016 and furthermore the reinforcing using fiber and the layering techniques has been studied by Muntongkaw, S. and et al., 2021. The technique use in this study is influenced by these studies.

Methodology

For this, Hana fiber is used and discarded paper sourced from newspaper vendors. They are kept in water for 24 hours and the water is removed. These are then broken into small pieces and bled. Here, blaring to the extent of 1-0.5mm is done because the above mixture got good results in the tests done earlier, and then this mixture is dried and powdered. Then paper and cement are mixed with water in different volume ratios and used to make samples.



Figure 2: Paper in water soaking



Figure 3: Paper Cement Mixture

The samples are made using a 150mm x150 mm x 5 mm wooden mold. The compression of the boards was done using hydraulic press. And they are subjected to the following tests and conclusions are drawn from observations. Also, these tests should be done on the currently used asbestos ceiling sheet and the new ceiling sheets should be compared with them for the analysis purpose. The ceilings that are expected to be made 5mm thickness, as commonly used asbestos ceiling sheets are also in same thickness.

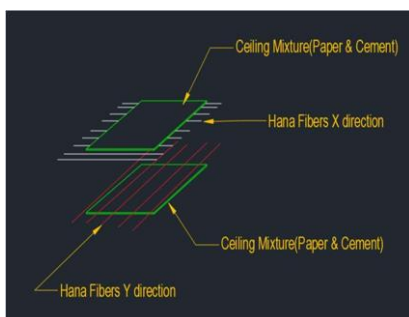


Figure 4: Fiber layering



Figure 5: Ceiling Sheet mold

Hana fibers were prepared with much care by boiling them under 100°C water to remove any fungus. And, then they are being air dried for 7 days and added to the cement and paper mixture under the selected different proportions considering the threshold values declared by the peer studied in cement paper mixtures. Samples were labeled as A, B, C, D and E under the following mix ratios.

Therefore, the volume of Hana fibers is kept as a constant at 10%, considering the density (Hana fibers: 860kg/m³) and volume calculations of the ceiling panel along with the weight of the Hana fibers after they are laid with a gap of 1mm in the 150x150mm area of 9.68g.

Table 1: Mix Design

Sample	Cement		Paper		Fiber		Total Volume
A	50625 mm ³	45%	50625 mm ³	45%	11250 mm ³	10%	112500 mm ³
B	56250 mm ³	50%	45000 mm ³	40%	11250 mm ³	10%	112500 mm ³
C	67500 mm ³	60%	33750 mm ³	30%	11250 mm ³	10%	112500 mm ³
D	78750 mm ³	70%	22500 mm ³	20%	11250 mm ³	10%	112500 mm ³
E	90000 mm ³	80%	11250 mm ³	10%	11250 mm ³	10%	112500 mm ³

These data converted to weight because of the less accurate measurement of paper by volume.

Table 2: Weight converted mix design

Sample	Cement	Paper	Fiber
A	72.90 g	35.44g	9.68g
B	81.00 g	31.50g	9.68g
C	97.20 g	23.63g	9.68g
D	113.40g	15.75g	9.68g
E	129.60g	7.88g	9.68g

As above, cement and paper are taken by weight and mixed with water, and samples are made using a mold as shown in figure.



Figure 6: Adding first layer of 2.5mm



Figure 7: Adding second layer after layering fibers

As shown above, the mixture is first spread approximately 2.5mm thick and then, prepared Hana fibers are spread at 1mm - 0.5mm intervals (Please refer to the Figure 6 & 7). The layering technique (Muntongkaw, S. and et al., 2021) is verified in peer studies and paper sizes used in paper mixture also based on the same reliable sizes discussed in the previous

similar studies. After that, the final layer is spread on the layered fiber with a thickness of 2.5mm.

A pressure of 1.2g/cm³ is then apply to this sample by using hydraulic jack. The same proved pressure in pilot study of ceilings preparation were used. And, it is pressure gauge in conventional ceiling board preparation. After that the mold is set at room temperature for about

3 days and then removed. The samples made above are subjected to the following tests to study physical characteristics of them and improve that characteristics by observing them.

Compression strength.

Here, the same compressor which is being used for concrete cubes is used.



Figure 8: Compressive strength machine



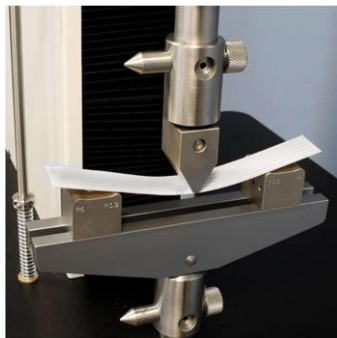
Figure 9: Compress the sample

$$C = P/A$$

Where; C- compressive strength, P- load “A” is cross sectional area of the sample.

Flexural Strength

This is a suitable test to measure the strength of a ceiling plate. The reason is that ceiling plate is a thin flat material. This test is often used to assess the physical properties of composite resinreinforced materials, particularly when subjected to bending forces. The load must be put in through two identical rollers arranged at the third point of the supporting span which is kept at center to center. The load shall be split equally between the two loading rollers, and all rollers shall be arranged in such a way that the load is laidaxially and without involving the sample in any torsional stresses or restraints.



$$F = 3PL/2WT^2$$

Where; F-flexural strength, P- maximum load, L-the dimension between load points, W-sample's width, T-thickness.

Figure 10: 3-point flexural test arrangement

Water Absorption

This test needs to be done for ceiling boards because the presence of water determines the possibility of fungal and insect damage. Therefore, the reason for conducting this test is to reduce the water absorption here as well as to determine the durability. Where; “M1” - Dry Weight after ventilated oven drying of specimen at 100-115 deg.C⁰ and “M2” - Wet Weight of specimen after immersion of sample in water for 24 hours.

$$W = (M2-M1) / M1 \times 100\%$$

Thermal Resistance

Thermal conductivity is also an important characteristic of a ceiling plate. Because this is what keeps the heat inside.

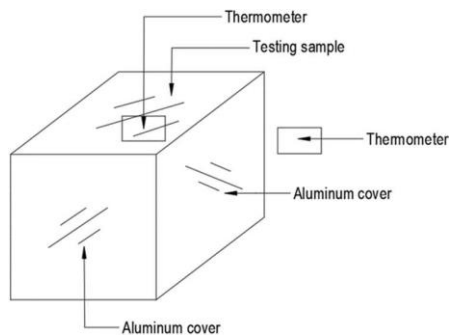


Figure 11: Thermal Resistance Sample Modeling

A 150x150x150mm size box is used for this, which is open one side only and covered with aluminum sheets on all other sides.

The sample is placed on the open side of the box and the value of two thermometers is recorded every hour between 10am- 3pm over a typical 5-days. the data related to the difference between the two temperature measurements is obtained.

$$R = (T2 - T1)/Q1-2$$

Results and Discussion

Density of Samples.

Check the volumes and densities of each sample.

$$D = W/V$$

Where; D- density (Kgm⁻³), W- mass (Kg) and “V” is volume (m³)

Table 3: Density Calculations.

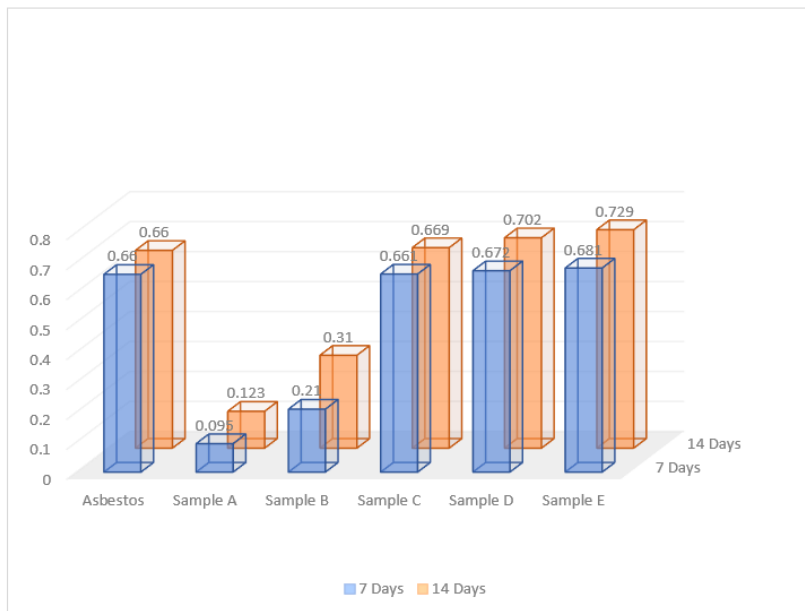
Sample	Length(m)	Width(m)	Height(m)	Volume(m ³)	Weight (Kg)	Density (Kgm ⁻³)
A	0.1501	0.1503	0.005	0.000113	0.11801	1046.187
B	0.1503	0.1503	0.005	0.000113	0.12217	1081.625
C	0.1502	0.1503	0.005	0.000113	0.13050	1156.143
D	0.1504	0.1502	0.005	0.000113	0.13883	1229.124
E	0.1501	0.1504	0.005	0.000113	0.14715	1303.652

The density of asbestos ceiling sheets is between 1200 – 1600 Kgm⁻³ and thus considering the density, sample D and E can be considered suitable.

Compression strength.

Table 4: Compressive strength Results

Samples	Asbestos	Sample A	Sample B	Sample C	Sample D	Sample E
Compressive strength (7 Day) kPa	660	95	210	661	672	681
Compression Strength (14 Day) kPa	660	123	310	669	702	729



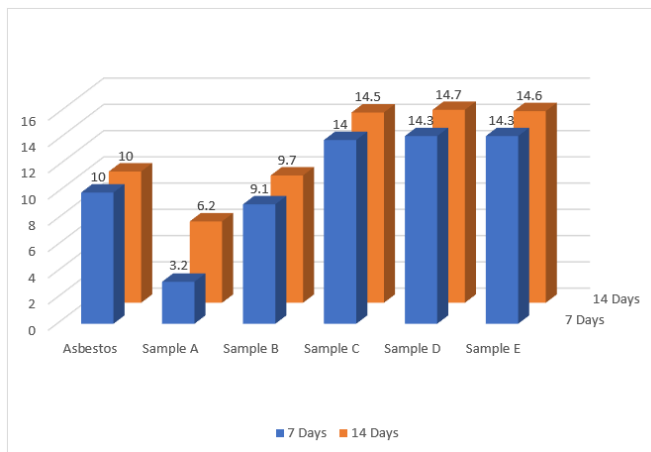
Graph 1: Comparison of compressive strength samples with asbestos (MPa)

Flexural Strength.

Above five samples were subjected to this test after 7 and 14 Days of curing, the flexural strength of each sample and asbestos.

Table 5: Flexural Test Results

Sample	maximum load (N) 7 Day	Maximum load(N) 14 Day	Length (mm)	Width (mm)	Thickness (mm)	Flexural strength (MPa) 7Day	Flexural Strength (MPa) 14 Day
Asbestos	83.33	83.33	150.00	75.00	5.00	10.00	10.00
A	26.65	51.63	150.10	75.00	5.00	3.20	6.20
B	75.68	80.67	150.30	75.00	5.00	9.10	9.70
C	116.51	120.67	150.20	75.00	5.00	14.00	14.50
D	118.85	122.17	150.40	75.00	5.00	14.30	14.70
E	119.09	121.59	150.10	75.00	5.00	14.30	14.60



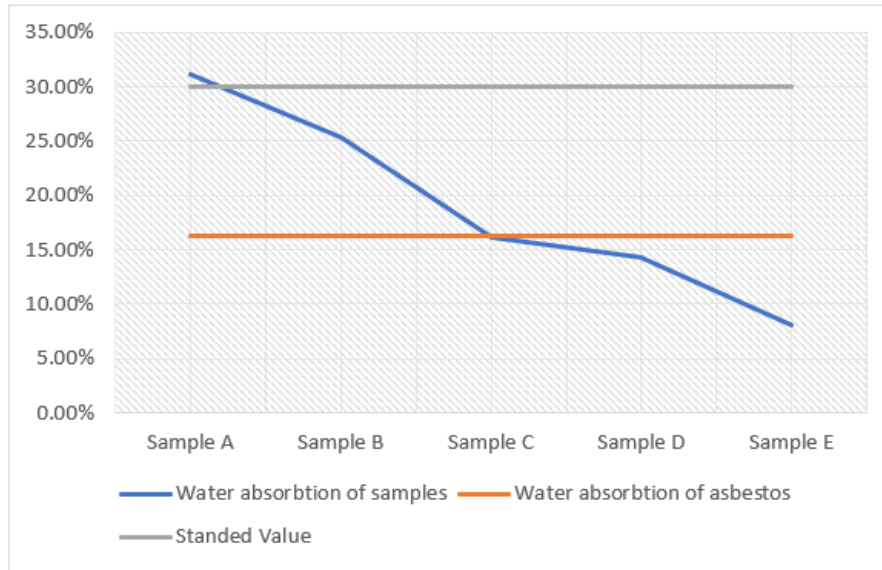
Graph 2: Comparison of flexural strength samples with asbestos (MPa)

Water Absorption

Here only samples curing 14 days were compared with asbestos ceiling sheet. The reason is because there was not much difference in the results of pilot tests.

Table 6: Water Absorption Results

Sample	M2 (g)	M1 (g)	M2-M1(g)	(M2-M1)/M1	(M2-M1)/M1 x 100%
Asbestos	154.98	133.20	21.78	0.16	16.35 %
A	154.07	117.50	36.57	0.31	31.12 %
B	152.06	121.30	30.76	0.25	25.36 %
C	149.78	128.90	20.88	0.16	16.20 %
D	157.78	138.10	19.68	0.14	14.25 %
E	158.73	146.80	11.93	0.08	8.13 %



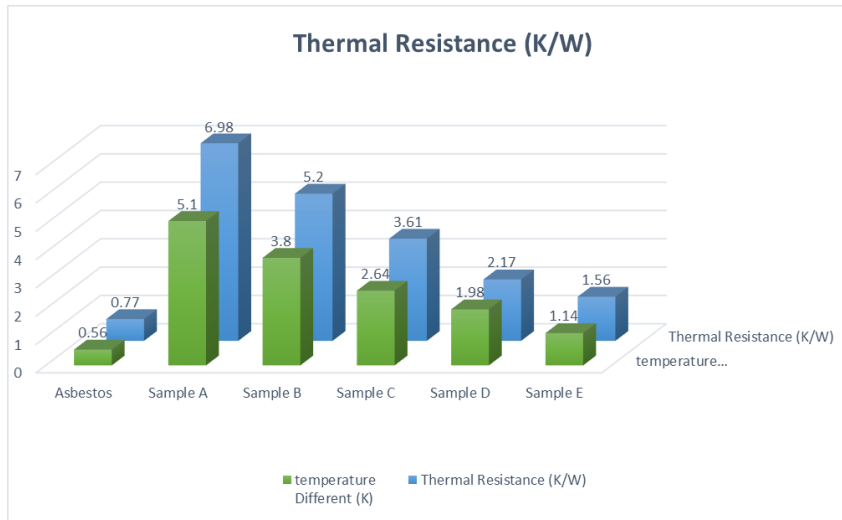
Graph 3: Comparison of water absorption samples with asbestos (%)

Thermal Resistance

Here only samples curing 14 days were compared with asbestos ceiling sheet. The reason is because there was not much difference in the results of pilot tests.

Table 7: Testing Data

Sample		Asbestos	A	B	C	D	E
Day 1	Inside (C ⁰)	29.50	25.00	26.00	28.00	28.90	29.10
	Outside (C ⁰)	30.00	30.00	30.00	30.00	30.00	30.00
Day 2	Inside (C ⁰)	30.60	25.20	26.90	27.80	29.00	29.20
	Outside (C ⁰)	31.00	31.00	31.00	31.00	31.00	31.00
Day 3	Inside (C ⁰)	30.70	26.00	27.00	28.00	29.00	30.00
	Outside (C ⁰)	31.00	31.00	31.00	31.00	31.00	31.00
Day 4	Inside (C ⁰)	29.40	25.30	27.10	28.20	28.00	29.20
	Outside (C ⁰)	30.00	30.00	30.00	30.00	30.00	30.00
Day 5	Inside (C ⁰)	30.00	26.00	27.00	27.80	28.20	29.80
	Outside (C ⁰)	31.00	31.00	31.00	31.00	31.00	31.00
Average	Inside (C ⁰)	30.04	25.50	26.80	27.96	28.62	29.46
	Outside (C ⁰)	30.60	30.60	30.60	30.60	30.60	30.60
temperature Different (K)		0.56	5.10	3.80	2.64	1.98	1.14
Thermal Resistance (K/W)		0.77	6.98	5.20	3.61	2.71	1.56



Graph 4: Thermal Resistance(K/W)

Conclusions and Recommendation

Through the pilot test and literature reviews it was concluded that using the range of 0.5 – 1 mm paper mix gives good result and fibers are spread at 1- 0.5mm intervals as shown in Figure 11. The reason for this is because it is as in the research studied for the 2nd above (Literature Reviews) and when the size of the pieces of the paper mixture used for this is equal to this, it goes through the gaps well and easily.

From the above compression test samples, A (0.123MPa, 0.095Mpa) and B (0.310MPa, 0.021MPa) are lower than the strength of asbestos(0.660MPa), while samples C (0.669Mpa, 0.661MPa), D (0.702MPa, 0.672MPa) and E (0.709MPa, 0.681MPa) are higher. Considering this test, it can be concluded that samples C, D and E are suitable.

From the above flexural strength test, samples; A (3.2MPa, 6.2Mpa) and B (9.1MPa, 9.7MPa) are lower than the strength of asbestos(10.0MPa), while samples C (14.0Mpa, 14.5MPa), D (14.3MPa, 14.7MPa) and E (14.3MPa, 14.6MPa) are higher. Considering this test, it can be concluded that samples C, D and E are suitable. Here the sample B also shows a significant level so the volume of cement can be taken as more than 50%. Considering this test only, there is no significant difference between 7 days and 14 days of curing, even if the cement volume ratio is increased up to 60%, there is no significant difference in the results, so increasing the cement volume ratio is useless.

According to the water absorption test values before sample C show higher water absorption than asbestos. That is 30% more samples with paper volume ratio. But all the samples except sample A are below the standard value so there is no problem. Accordingly, all samples except sample A, are suitable. And samples C, D and E are more suitable.

According to the thermal resistance above, it appears that all the samples have higher thermal resistance compared to asbestos. And as the paper volume ratio increases, it appears that the thermal resistance increases. Thus, it can be concluded that all the samples are suitable.

Here sample D and sample E shows higher success results in some tests, but because of high cement volume ratio it is financially disadvantageous in commercial production. Finally, can be concluded that sample C (14-day curing) is suitable for commercial production as a ceiling board. This study can find as a successful attempt on finding an alternative solution for

ceiling sheet production with readily available raw materials in the demand of the construction industry as currently used asbestos is toxic and expensive.

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POTENTIAL OF SLUDGE AS A PARTIAL REPLACEMENT FOR GYPSUM IN CEILING TILES

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Abstract

The current initiative focuses on the Potential of sludge as a partial replacement for gypsum in ceiling tiles. The impact of replacing water treatment plant sludge in the composite with gypsum is also being investigated and also the mechanical, physical, and acoustical properties of the composite gypsum with sludge are being evaluated. Sludge and gypsum blends were employed to improve the characteristics and performance of gypsum ceiling tiles in this investigation. Composites are made with 0–25 percent sludge and the rest gypsum, with the percentage of sludge changing between 0–25 percent. Here investigate the sludge's gypsum strength and flame propagation distances, as well as its water absorption properties. The compressive strength was found to have a minimum value of 3.4MPa with 25% of sludge mixed, which is acceptable for a non-load-bearing ceiling tile. The maximum water absorption was recorded to be 18.5% with 25% of sludge mixed. The flame propagation value, which is recorded as a maximum 75mm still shows that these specimens are 0% specimens which do not ignite or contribute to fires.

Keywords: Ceiling Tiles, Gypsum, Potential, Sludge, Replacement

Introduction

In the modern day, issues related to the environment are high. Therefore, each and every construction is now being monitored and directed towards a new environmental friendly systematic manner (Products *et al.*, 2017). In this case, there are standards generated to direct this kind of construction to an acceptable shape. Among these constructions, ceiling board manufacturing is one of the common and famous processes in large-scale as well as small-scale businesses.

Gypsum boards have taken a good place in the construction industry. But eventually, the raw materials for this industry have become endangered. Due to a lack of raw materials, some of the manufacturers have stopped production and some of them are looking for alternatives. Therefore, one of the alternatives is this sludge which is generated as a result of drinking water treatment plant waste. Gypsum is replaced using this drinking water treatment plant sludge. This research is aimed to find out the suitability and the suitable percentages of sludge to be used for manufacturing gypsum boards for ceiling tiles. (Products *et al.*, 2017)

Gypsum and additive Slurry used in this process is conventionally made out of materials directly found from the environment. Those materials are decaying with the time. So, alternative materials should be found to overcome this problem. In this research, gypsum is considered the key material and that is to be replaced by alternative materials since that material is being decayed. (Morsy, Shebl and Saif, 2008).

In this research this sludge which are taken from water treatment plants, are mixed with gypsum with pre-defined proportions and see which proportion is suitable for commercial applications. In that, the suitability, preserving of properties and qualities and the cost is also

considered. Finding the best replaceable material for gypsum will make the construction process very cheap and environmental friendly.

Aim

The aim of this research is to investigate the usage of sludge from water treatment sludge combining with gypsum, and to assess the impact of combining water treatment sludge with gypsum in ceiling tiles.

Methodology

Since this is a quantitative study, numerous tests will be carried out to ensure that the finished product satisfies all applicable standards and is in line with the requirements. The process of this research will be based on scientific experiments, not on the data collection from the industry nor the surveys. Practical approach is used to determine the results of property analysis of the material and the properties of the end product is analyzed.

Various tests will be carried out to ensure that the end product's qualities meet all of the available requirements in accordance with standards. Strength of ceiling tiles, water absorption, and fire resistance will be investigated as the main features. Samples with varying sludge percentages were generated and burnt in a kiln; the results on mechanical and physical qualities suggest that dry sludge can be utilized with gypsum at percentages ranging from 0% to 25% of the gypsum ceiling, and compressive strength declines as sludge content increases. Uneven texture surface and porosity result from the burnt off organic component of sludge during the fire process. Dry sludge with no organic material was introduced or replaced to alleviate this problem. Although the ceiling is used as a non-load bearing spacing construction material, the sludge will be tested to see if it has any properties in terms of water absorption and compressive strength that meet the required standards. When using sludge from water treatment in the manufacturing of ceilings. The gypsum ceiling's mechanical qualities will be tested in accordance with industry standards and also Different temperatures will be used to burn the samples. The product's qualities will be investigated and compared to traditional ceilings in compliance with Sri Lankan standards.

To discover guiding principles and study the research, academic journals, as well as other document types, such as original documents and literature, were evaluated. The acquired data has been used to complete the research project and as a foundation for attaining the other goals of this study.

To create ceiling tiles using gypsum as a partial replacement for water treatment sludge at various mixing percentages. Making a sample with the necessary structure can help to achieve the aim. Mostly in industry, gypsum is commonly utilized. Sludge content varies from 0 to 25% in composite materials, with the remaining material being gypsum. Here, look into the gypsum strength, flame propagation distances, and water absorption characteristics of the sludge. With 25% of sludge mixed in, which is suitable for a ceiling tile that is not intended to support loads.

Table 01: **Sludge with gypsum adding % for samples**

Sample	01	02	03	04	05	06
Sludge	0%	5%	10%	15%	20%	25%
Gypsum	100%	95%	90%	85%	80%	75%

This is Quantitative research so several testing will be conducted to guarantee that the end product meets all of the accessible criteria in accordance with the specifications. The major aspects to be researched are ceiling tile strength, water absorption, and fire resistance. Pressure curing of the gypsum-based combination will be used as a measurement technique for minimizing moisture content. Several tests will be run to make sure the final product's attributes meet all of the requirements and adhere to standards. As the major features, ceiling tile strength, water absorption, and fire resistance will be examined. Samples with different sludge percentages were produced and burned in a kiln; the mechanical and physical properties indicate that dry sludge can be used with gypsum at percentages ranging from 0% to 25% of the gypsum ceiling, and compressive strength decreases as sludge content increases. The organic material in the sludge that burns off during the fire process gives the surface an uneven texture and porosity. To solve this issue, dry sludge devoid of organic content was added or substituted. This approach allows for a decrease in the amount of water required in the combination while minimizing the void content. This method allows for the creation of a considerably more condensed combination, which improves its performance greatly. At this point, a low-consistency mixture was made by combining gypsum with the bare minimum of moisture (in mass).

Test used to determine the properties of the ceiling gypsum tiles are mentioned in the below.

1. Strength of ceiling tiles
2. Water absorption
3. Fire resistance

Everything should be discussed. Based on the data, assess the results and recommend a reasonable sludge replacement % for gypsum in ceiling tiles. Excel was utilized as a tool in this analysis since it can handle faults on its own and is a good technique to tackle research problems. Gypsum tiles are used in the modern construction industry since a long time ago. These tiles are having a set of qualities that the industry is always aiming for. These tiles are cheap in cost and the strength is considerably fine for the requirements. Mostly, because of its water molecules which are chemically bonded to the gypsum compound, the flammability is very low therefore sometimes it can be taken as non-flammable tiles.

Results

Data analysis is the most important aspect of any study. Analysis of data describes the information gathered. It entails the use of analytical and logical reasoning to data in order to identify trends, correlations, or developments. During the data analysis process, three important things happen: first, classification method. The combination of description and classification has led to the 2 most often used data removal system. It facilitates the detection and connection of patterns and themes in data. Data analysis is the third and final method, which can be done top-down or bottom-up. Therefore, since the flame propagation is not

changed in the 15% of sludge mixed gypsum specimens, and a higher water absorption is better for a more fire resistance, the mixes with up to 15% of gypsum mixes can be taken as usable products. In such cases, the required compressive strength should be considered according to the construction requirement.

Strength of gypsum with water treatment sludge

Compressive strength results are shown in the below. Compressive strength test was done according to the EN 196-1: 2005.

Test of 100% Gypsum + 0% Water treatment sludge

Table 02: Test of 100% Gypsum + 0% Water treatment sludge

Specimen No.		01	02	03
Date Cast		25/03/2022	25/03/2022	25/03/2022
Date Test		25/03/2022	25/03/2022	25/03/2022
Heated for	Hours	1	1	1
Sectional Area	cm ²	64	64	64
Specimen Width	mm	40.00	40.00	40.00
Specimen Length	mm	160.00	160.00	160.00
Specimen Height	mm	40.00	40.00	40.00
Volume of Specimen	cm ³	256	256	256
Weight of Specimen	g	365	360	355
Unit Weight	kg/m ³	1.43	1.41	1.39
Failure Load	kN	103.7	104.3	108.8
Compressive Strength	N/mm ²	16.2	16.3	17.0

Test of 85% Gypsum + 15% Water treatment sludge

Table 03: Test of 85% Gypsum + 15% Water treatment sludge

Specimen No.		01	02	03
Date Cast		25/03/2022	25/03/2022	25/03/2022
Date Test		25/03/2022	25/03/2022	25/03/2022
Heated for	Hours	1	1	1
Sectional Area	cm ²	64	64	64
Specimen Width	mm	40.00	40.00	40.00
Specimen Length	mm	160.00	160.00	160.00
Specimen Height	mm	40.00	40.00	40.00
Volume of Specimen	cm ³	256	256	256
Weight of Specimen	g	265	260	260
Unit Weight	kg/m ³	1.04	1.02	1.02
Failure Load	kN	39.7	37.1	34.6
Compressive Strength	N/mm ²	6.2	5.8	5.4

Test of 75% Gypsum + 25% Water treatment sludge

Table 04: Test of 75% Gypsum + 25% Water treatment sludge

Specimen No.		01	02	03
Date Cast		25/03/2022	25/03/2022	25/03/2022
Date Test		25/03/2022	25/03/2022	25/03/2022
Heated for	Hours	1	1	1
Sectional Area	cm ²	64	64	64
Specimen Width	mm	40.00	40.00	40.00
Specimen Length	mm	160.00	160.00	160.00
Specimen Height	mm	40.00	40.00	40.00
Volume of Specimen	cm ³	256	256	256
Weight of Specimen	g	220	215	215
Unit Weight	kg/m ³	0.86	0.84	0.84
Failure Load	kN	20.5	21.1	23.0
Compressive Strength	N/mm ²	3.2	3.3	3.6

Weights of prisms

Table 05: Weights of prisms

	Prism 1 (g)	Prism 2 (g)	Prism 3 (g)
0% sludge	365	360	355
5% sludge	335	345	340
15% sludge	265	260	260
25% sludge	220	215	215

Summary of the compressive strength results

Table 06: Summary of the compressive strength results

Sludge %	Prism 1	Prism 2	Prism 3
0	16.2	16.3	17.0
5	10.5	9.6	11.1
15	6.2	5.8	5.4
25	3.2	3.3	3.6

Water absorption of gypsum with water treatment materials

Water absorption of gypsum and sludge mix specimens test was done according to the ASTM D570. Results are shown in the below.

Table 07: water absorption test results of gypsum and water treatment sludge

Sample No	100% Gypsum 0% sludge	95% Gypsum 5% sludge	85% Gypsum 15% sludge	75% Gypsum 25% sludge
Condition	Normal	Normal	Normal	Normal
Immersion time	24 hours	24 hours	24 hours	24 hours
Dry Density (kg/m ³)	668	618	584	543
Volume of the sample (cm ³)	12.26	12.26	12.26	12.26
Oven Dried Mass (g)	8.2	7.6	7.2	6.7
Mass after Immersion (g)	9.0	8.4	8.2	7.9
Absorption %	9.6	11.2	14.6	18.5

Fire resistance of gypsum with water treatment materials

Classification of surface spread of flame test has been done according to the BS 476 part 7 : 1997 – fire test on building materials and structures.

The results are shown in the below,

Table 08: Classification of surface spread of flame test results

Specimen	100% Gypsum 0% sludge	95% Gypsum 5% sludge	85% Gypsum 15% sludge	75% Gypsum 25% sludge
Spread of flame at 1.5min (mm)	NIL	NIL	NIL	NIL
distance (mm)	Time of spread of the flame to indicated distances (min.sec)			
75	NIL	NIL	NIL	9.50
165	NIL	NIL	NIL	NIL
190	NIL	NIL	NIL	NIL
215	NIL	NIL	NIL	NIL
240	NIL	NIL	NIL	NIL
265	NIL	NIL	NIL	NIL
290	NIL	NIL	NIL	NIL
375	NIL	NIL	NIL	NIL
455	NIL	NIL	NIL	NIL
500	NIL	NIL	NIL	NIL
525	NIL	NIL	NIL	NIL
600	NIL	NIL	NIL	NIL

675	NIL	NIL	NIL	NIL
710	NIL	NIL	NIL	NIL
750	NIL	NIL	NIL	NIL
785	NIL	NIL	NIL	NIL
825	NIL	NIL	NIL	NIL
865	NIL	NIL	NIL	NIL
Time of maximum spread of flame (min.sec)	10.00	10.00	10.00	10.00
Distance of maximum spread of flame (mm)	50.00	50.00	50.00	75.00

NIL-Neutral

Result analysis

Weight variation of the prisms

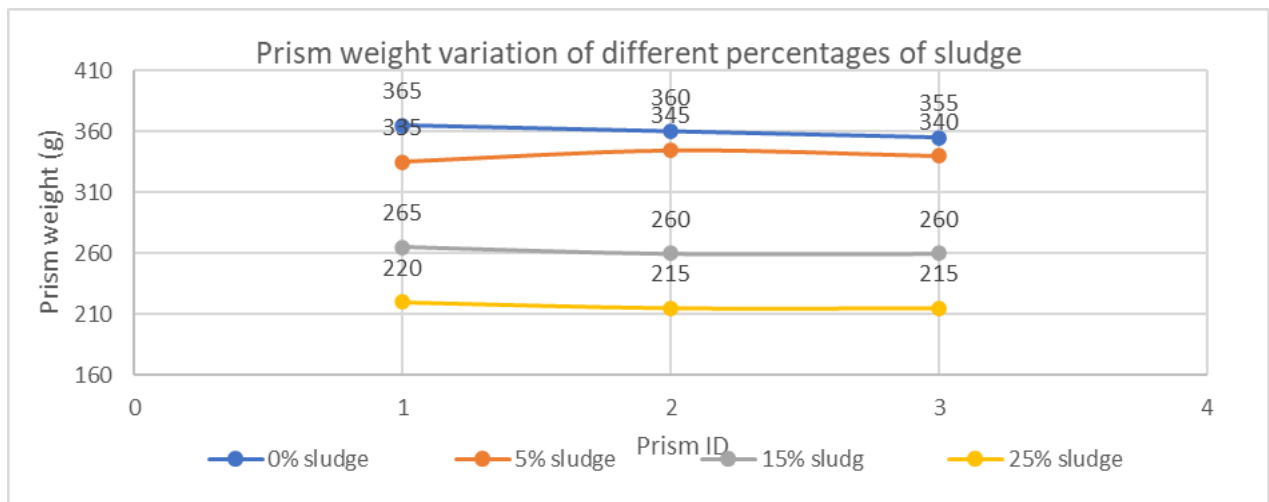


Figure 01: Prism weight variation of different percentages of sludge

Compressive strength individual variation

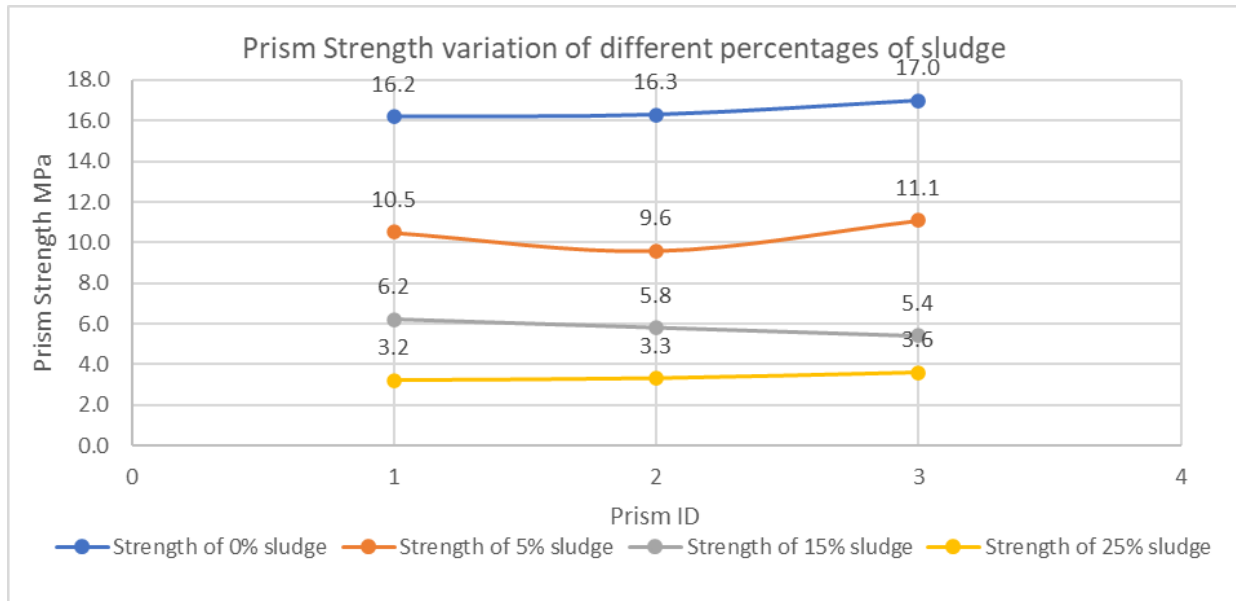


Figure 02: Prism Strength variation of different percentages of sludge

Compressive strength average value variation

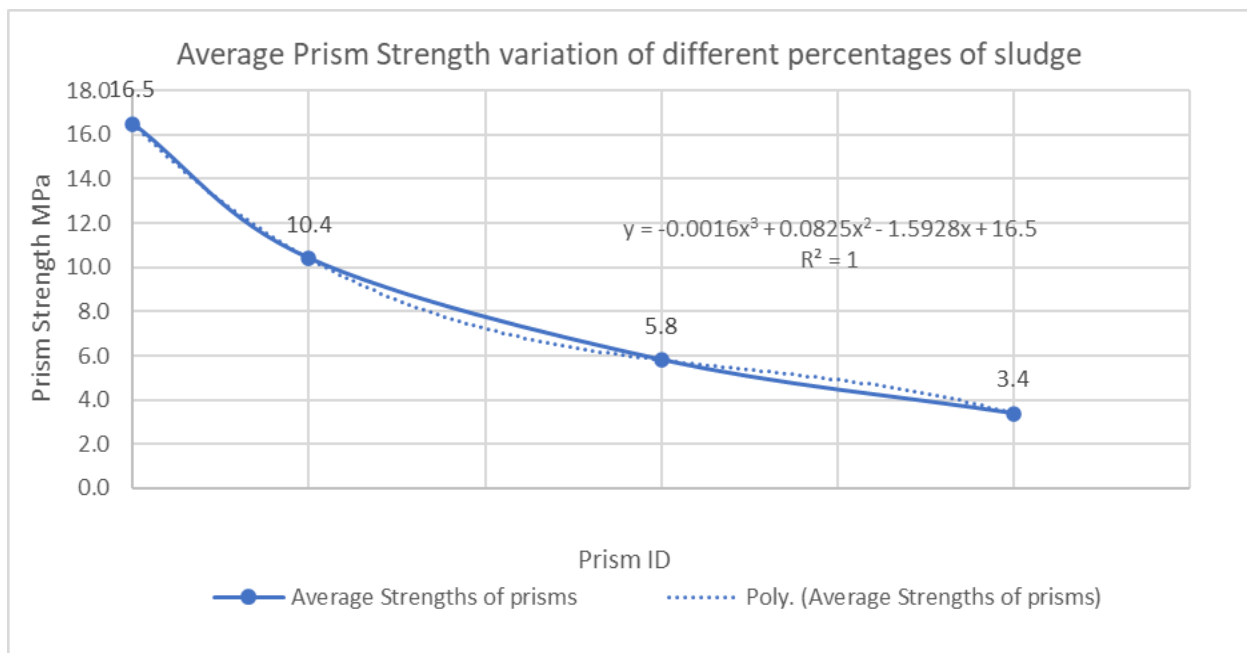


Figure 03: Average Prism Strength variation of different percentages of sludge

Fire test flame propagation variation

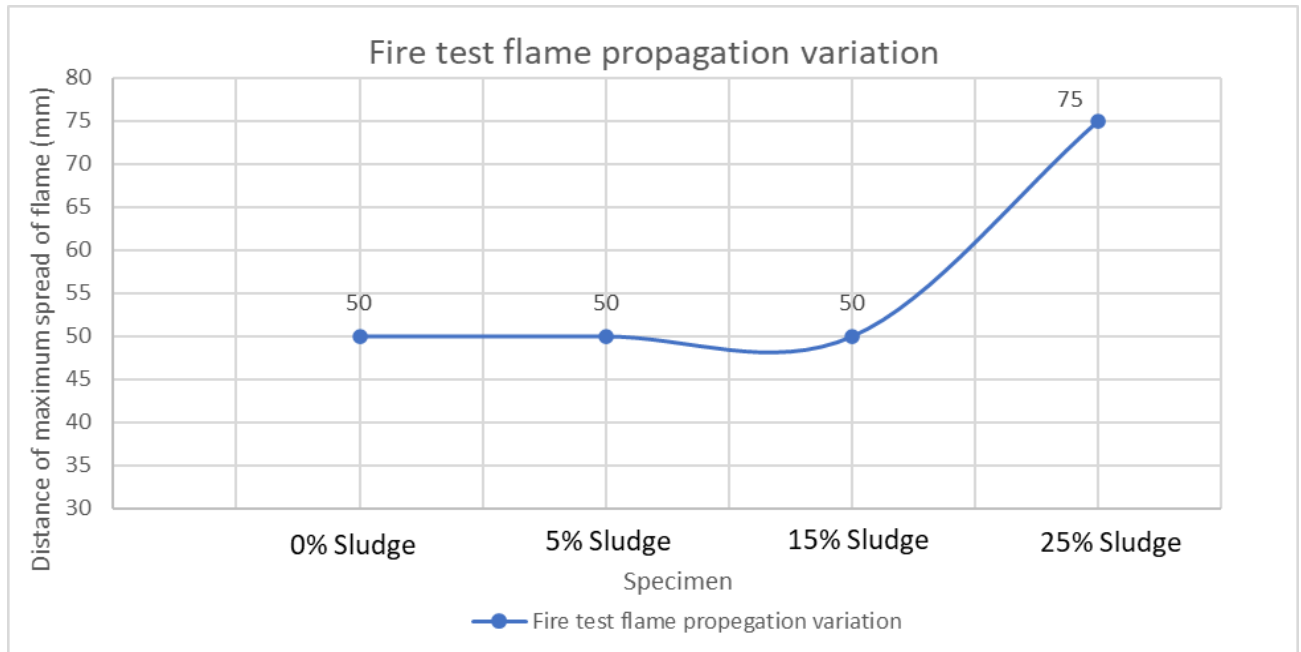


Figure 04: Fire test flame propagation variation

Discussion

Gypsum boards are used in the modern construction industry since a long time ago. These boards are having a set of qualities that the industry is always aiming for. These boards are cheap in cost and the strength is considerably fine for the requirements. Mostly, because of its water molecules which are chemically bonded to the gypsum compound, the flammability is very low therefore sometimes it can be taken as non-flammable boards.

As seen in the figure 1, the weight variation of the prisms are shown with a clear difference of the weights of the different sludge percentages. As seen in the graph, the highest weight of the prisms are shown in the mix without sludge. Then the next highest weight is shown in the mix with sludge percentage of 5%. Both of them are showing a quite close value. Apart from that, the mix with 15% sludge shows a significant difference in the weight from the 5% sludge mix weight. At the end the lowest weight of the prisms are shown in the mix with 25% of sludge mix. It appears that, with the increment of the sludge percentage, the weight of the prisms has been decreased. It shows that adding proper amount of sludge by preserving the other properties like compressive strength and the fire resistance, this process can make light weight gypsum boards and can reduce the weight of the building significantly. This would reduce the cost of the other material which should use to support the ceiling work too. By reducing the weight of them, the strengths that is required to hold the ceiling tiles is also getting low. Therefore, the cost which is required to make heavy materials will be reduced by using these lightweight materials.

As seen in the figure 2, the compressive strength of the individual prisms shows a clear variation. The highest compressive strength is shown by the mix which has no water

treatment sludge materials. After that, the second highest compressive strength is shown in the mix which has 5% of water treatment sludge. The gap between the highest compressive strength and the second highest compressive strength is significantly high. After that the third highest compressive strength is shown in the mix which has a water treatment sludge 15%. Finally, the lowest compressive strength is shown in the mix which has 25% of water treatment sludge. Final three compressive strength values have a slight close value. Compressive strength in the whole assembly of ceiling will be depend on the wood's modulus of elasticity (Grenier, 2014).

Water absorption of the specimens, are shown in the figure 4. As seen in the same figure, the water absorption has an increment from the initial sample which has no water treatment sludge in it. With the increment of the sludge percentage in the mix, the water absorption has been increased. This property will be a very good feature when it comes to fire resistance of the gypsum ceiling boards. Since one of the main features of the gypsum boards is the fire resistance, this water absorption properties will help to increase that fire resistance property. As the chemical formula of the gypsum shows two water molecules, it originally helps fire to be stopped by making a mist when the gypsum boards are ignited. That mist is generated when the fire is reacting with the water molecules in the gypsum. Having additional absorbed water at a safe level will help this fire resistance positively.

Finally, the fire resistance and fire flame propagation behavior are shown in the figure 5. The test which was used here to determine the fire flame propagation rates is BS 476 part 7: 1997 ('Fire tests on building materials and structures', 1997). According to that testing code, a maximum of 10 minutes are used to conduct the test. According to the flame propagation distance, the fire properties of the gypsum board is defined. In this test, a straight line is drawn in the frame of the gypsum board where it is fitted before igniting. Then the distances are marked on the gypsum board too. The required distances have been mentioned in the figure 7 – Reference lines to assist surface spread of flame classification. After drawing these lines, the board is ignited from the zero distance end. Then the time taken for the flame propagation is measured. Initially the distance of the flame propagate in the initial 1.5 minutes is measured and marked. After that the time taken to propagate the flames to the marked lines are observed and recorded in the working sheet. At the end, the Distance of maximum spread of flame (mm) after 10 minutes of the test is observed and recorded. If the material is more resistant to fire and the flame propagation, the distance of the flame travelled at the end of the test is very low.

Conclusion and Recommendations

Gypsum is using in many industries but mostly in the construction industry as wall boards or gypsum boards. Since the increased use of this material has caused difficulties in finding the same quality materials because natural resources are in danger, alternative materials or partial replacement materials will help the industry to go forward. This test has found following findings.

Mixing of sludge with gypsum has made lightweight materials which can help the industry to have economically friendly construction methods.

Compressive strength of the sludge mixed gypsum prisms has been decreased with the increment of the sludge mix percentage.

Water absorption of the specimens have been increased with the increment of the water treatment sludge in the mix.

Fire resistance is higher in the pure gypsum boards and even if the gypsum is mixed with sludge, the fire resistance has not been changed even the sludge percentage is increased up to 15% in the mix.

Therefore, since the flame propagation is not changed in the 15% of sludge mixed gypsum specimens, and a higher water absorption is better for a more fire resistance, the mixes with up to 15% of gypsum mixes can be taken as usable products. In such cases, the required compressive strength should be considered according to the construction requirement.

As mentioned in the study (Petrone, Magliulo and Manfredi, 2016), the quality of the gypsum boards can further be defined and developed doing tension tests, flexural strength test and bending tests.

As found in the flame propagation test, these specimens are class 1 materials which resist any stage of the fire including the fully developed fire. As mentioned in the table 2 at clause 11.5 in the BS 476 part 7, the class 1 materials which resists fires and does not contribute to fires.

Research has the potential to advance the ceiling business, which uses alternatives to gypsum. Additionally, it can lower the cost of completing work in building, generate new sources of employment.

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A STUDY ABOUT THE IMPACT OF COST ESTIMATING USING BUILDING INFORMATION MODELING IN CONSTRUCTION PROJECT

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Abstract

Building Information Modelling (BIM) is the process of creating digital models for use in the planning, design, construction, and operation of a facility. While BIM is gaining a lot of attention in Sri Lanka right now, it appears that widespread knowledge of it is still lacking. The research has proven that BIM has the potential to change the way the construction industry functions, with the goal of this study being to determine the usefulness of BIM for cost consultants and its impact on cost estimating. An in-depth analysis of existing literature was used to build a conceptual framework that was used to examine the possible benefits and obstacles for cost consultants who employ BIM in their work practices. This study has the potential to help practitioners better understand BIM and how it may be integrated into current working practices, as well as uncover possible areas for cost consultancy services expansion through BIM deployment.

Keywords: Building information Modeling, BIM, QS, CS, Cost Estimating

Introduction

Building information modeling (BIM), like any other innovation method, must go through a process of validation in the Central European region, both with the professional public and, most importantly, with the investors themselves, to ensure that it has a higher degree of applicability than the existing traditional solution. It is a cutting-edge instrument for resolving both technical and financial challenges in construction projects. The current use of new technology and methodologies to determine the most cost-effective method of assessing construction costs is further bolstered by society's increasing need for accuracy and transparency in disclosed building prices in public construction projects. In practically all building industries and phases, information modeling is advancing. (Horelica et al 2017, Ministry of Industry and Trade 2017) Cost management, also known as BIM 5D, presents several challenges in the form of adapting workflows and related procedures to meet information modeling requirements. Cost estimation during the project preparation stage is a critical aspect of cost management. The traditional method of determining it is time-consuming and prone to errors. In comparison to today's current technologies, reading 2D paperwork, which serves as a basis for the customary cost assessment of structures / construction activities, is antiquated. As a result, now is the moment to begin employing sophisticated tools to produce predictions that are more realistic, quicker, more trustworthy, and adaptable.

Research Objectives

By utilizing Building Information Modeling, the study seeks to discover the cost estimating technique utilized in building projects (BIM). Several goals must be met in order to accomplish this goal, and they are as follows:

1. To describe BIM and examine how the building sector has changed to adopt its use,
2. to carry out a thorough literature assessment on BIM applications for estimating building costs.
3. To examine how BIM's benefits affect cost estimation
4. to determine if building information modeling may be used in Sri Lanka for cost estimates.

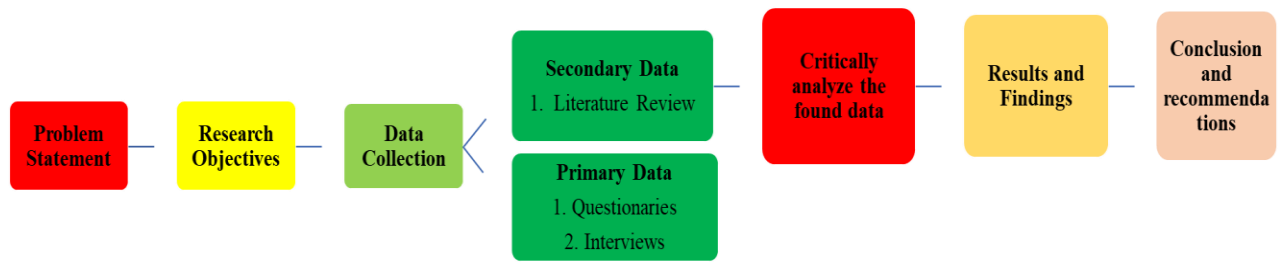
Methodology

The systematic procedure of doing research is referred to as research methodology. Many different techniques are employed in different forms of research, although the phrase is commonly used to refer to study design, data collection, and data analysis. When we discuss research methodology in relation to a research problem or study, we usually get answers to the following questions: why a research study was undertaken, how the research problem was defined, how and why the hypothesis was formulated, what data was collected and what method was used, why a particular technique of data analysis was used, and a slew of other questions.

Quantitative research approaches (for example, counting the number of times someone performs something under particular conditions) and qualitative research procedures (for example, counting the number of times someone does something under certain conditions) are both available (for example, asking people how they feel about a certain situation). In an ideal world, complete research would include qualitative and quantitative approaches, but this isn't always attainable owing to time and budget restrictions. In academic research, research procedures are commonly employed to examine hypotheses or ideas. A good design ensures that the study is both valid and trustworthy, in that it explicitly evaluates the hypothesis and excludes unnecessary factors, and that the results are consistent every time.

The manner in which the research is carried out is a part of the research methodology. This is known as the study design, and it often involves surveys, interviews, observation, and/or experiments. The word research methodology refers to the techniques used to evaluate and interpret the data collected and specifies the research approach to be used. To detect correlations or statistical significance in the results, they frequently employ a variety of advanced statistical analysis of the data.

Research technique is the way of gathering data for research undertakings. Data can be collected for theoretical or practical study, such as management research, operational planning approaches, and change management. Validity of research data, ethics, and the dependability of the majority of your work is completed by the time you finish analyzing your data are all significant variables in research technique. The research design, which might be experimental or quasi-experimental, comes next. The remaining two processes are data analysis and eventually drafting the research report, which is meticulously organized into graphs and tables to display just the most significant and relevant facts.



Result

The purpose of this chapter is to outline the most important conclusions of this study. Conclusions will be correlated with the objectives of the dissertation and will bring the subjects relevant to the objectives. Further, suggestions for further research will be made. Based on the review, many problems were identified in cost estimating with BIM.

Discussion

As the purpose of this research was to find out; Usability and impact of cost estimating using building information modeling in construction project.

After the results discussion and interpretation were conducted, the study concluded the following,

In a construction project, above investigations established the value and influence of cost estimating using building information modeling; in Sri Lankan construction, its medium. How crucial is it for Sri Lanka to understand building information modeling and create budgets, in addition? The majority of respondents claimed to utilize BIM software for construction models and estimation. Those who claim they never use it also claim they intend to do so in the future.

Future projects in Sri Lanka, cost estimation utilizing building information modeling will facilitate project execution in Sri Lanka, according to the aforementioned assessments, The respondents evaluated several estimating approaches by manually taking off from 2D drawings, a common procedure in the Sri Lankan industry.

Utilizing building information modeling for cost estimation in construction projects to determine time, labor, and economic advantages The results show that BIM benefits and functions are very beneficial to professionals in Sri Lanka's building industry. BIM features are incredibly important and crucial for them. The BIM element that garnered the highest overall rating from respondents was construction site management. On the other side, the study's findings showed that barriers to BIM adoption are restricting its use in Sri Lanka's construction sector. The primary obstacles to BIM adoption, as indicated by the responses, are:

1. the projects we work on are too small
2. BIM is not always relevant to the projects we work on.

Finally, when it comes to BIM advantages in cost estimate, the BIM benefit that received the highest overall response was better cost estimation at each project stage.

Recommendations

Based on the finding of the study, the respondents recommend the follows,

How it affects the cost estimation using the building information modeling of the construction project

- Can estimate the real cost of the current work and future work too.
- It speeds up the process of taking off quantities and preparation of BOQ's
- BIM is a very helpful application to the construction industry.
- It is very useful method while conducting construction stage
- It affects the cost estimation as a risk management tool
- Since all can be visualized before building, the re work cost will be minimal. Cost can be prepared/matched on 100% of client requirement
- Through BIM the estimations can be get as more accurate as possible
- BIM is better thing to use for the cost estimating and other familiar works
- I have poor knowledge about BIM
- It can easily get the cost estimation using BIM within very short period and all information are in one location and it is very easy to handle the project.
- Cost Estimating is yet other aspects of the building process that can benefit from computable building information.
- When estimating cost, BIM is very accurate software. And we can avoid mistakes of cost estimate process.

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ANALYZING THE BEHAVIOUR OF STRESS ABSORBING LAYER IN REACTIVE SOIL TO PREVENT WALL CRACKS

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Abstract

To introduce using of stress absorbing layer below the foundation of the superstructure in low-rise buildings that can evade slabs and wall cracks by using as an isolation from ground movements caused by climate and seasonal changes. A layer has been introduced in previous research with material such as SAND-RUBBER MIXTURE (SRM). But using of SRM as a foundation interlayer could lead to higher settlement of foundation and low bearing capacity. However, for this problem, the usage of SAND-QUARRY DUST-RUBBER-SAW DUST MIXTURE (SQRSM) has been proposed here. The reactivity of the soil and coefficient of permeability has been calculated as, the LL as 20%, PL as 16% and PI as 4%. In permeability test, the K value has been calculated as, 0.009% in S1, 0.06% in S2, 0.03% in S3 and 0.01% in S4. As per the CBR tests, values have been calculated as, 1.2% in S1, 0.5% in S2, 0.4% in S3, 0.5% in S4 and 0.7% in S5. Considering CBR value and permeability coefficient value, the most suitable SQRSM layer has been chosen as Sample 01.

Key Words: Wall cracks, Stress absorbing layer, Isolation of foundation, Sand-Quarry Dust-Rubber-Saw Dust Mixture, Load bearing capacity.

Introduction

This research is about finding a solution for wall cracks due to foundation instability caused by ground movements. These ground movements take place in climate and seasonal changes and due to reactive soil (clay-based soil) that expand dramatically when wet and contract when dry. Using of stress absorbing membrane underneath the foundation of low-rise buildings which have reactive soil types as the base could evade these slabs and wall cracks. By this research, the researcher introduces using of a stress absorbing membrane made of Sand-Quarry Dust-Rubber-Saw dust Mixture (SQRSM).

As per some of the previous researches on Geo Seismic Isolation to prevent earthquake damages, it could be used a material with higher damping strength and low shear modulus to isolate foundation from ground movements. This SQRSM is developed by adding Saw dust & Quarry dust to Sand-Rubber Mixture (SRM) material that is introduced by previous research, to increase load bearing capacity and stress absorbing strength. (Dhanya, Boominathan and Banerjee, 2020). Usage of tire crumbs as rubber in this gives out distinct features such as resistance for high friction, strength, ductility etc. After finding out reactivity of the soil and coefficient of permeability through Permeability and CBR tests, the SQRSM mixing ratios and the most suitable layer sample with higher CBR value and lower permeability value has been found out. After verifying previous researches, it is prudent that no one has looked into the matter of using stress absorbing material underneath low-rise building foundations, but all previous researches were based on earthquake resistance and reducing the damage upon buildings by earthquakes. Therefore, the researcher has done the

research on the topic of “ANALYZING THE BEHAVIOUR OF STRESS ABSORBING LAYER IN REACTIVE SOIL TO PREVENT WALL CRACKS”.



Image 01- Wall cracks due to ground instability

Aims and Objectives

Aim

- ☐ Introducing the usage of, stress absorbing layer below the foundation of the superstructure in low-rise buildings to evade cracks in walls and slabs.

Objectives

- ☐ To evaluate the levels of stress that exerts by reactive soils upon building foundations and level of instability of low-rise building foundations due to ground movements caused by climatic changes and reactive soil.
- ☐ To find out additional materials to be added in to SRM, to increase load bearing capacity and stress absorbing strength.
- ☐ To examine that this new material could withstand the stress levels that are exerted by reactive soils and proper ways to apply it beneath low-rise building foundations.

Methodology

To achieve the goal of usage of stress absorbing layer as low-rise building foundation isolator from ground movements that caused by climatic changes and reactive soil, the researcher has listed the key steps to follow in the methodology as shown in Image 02,

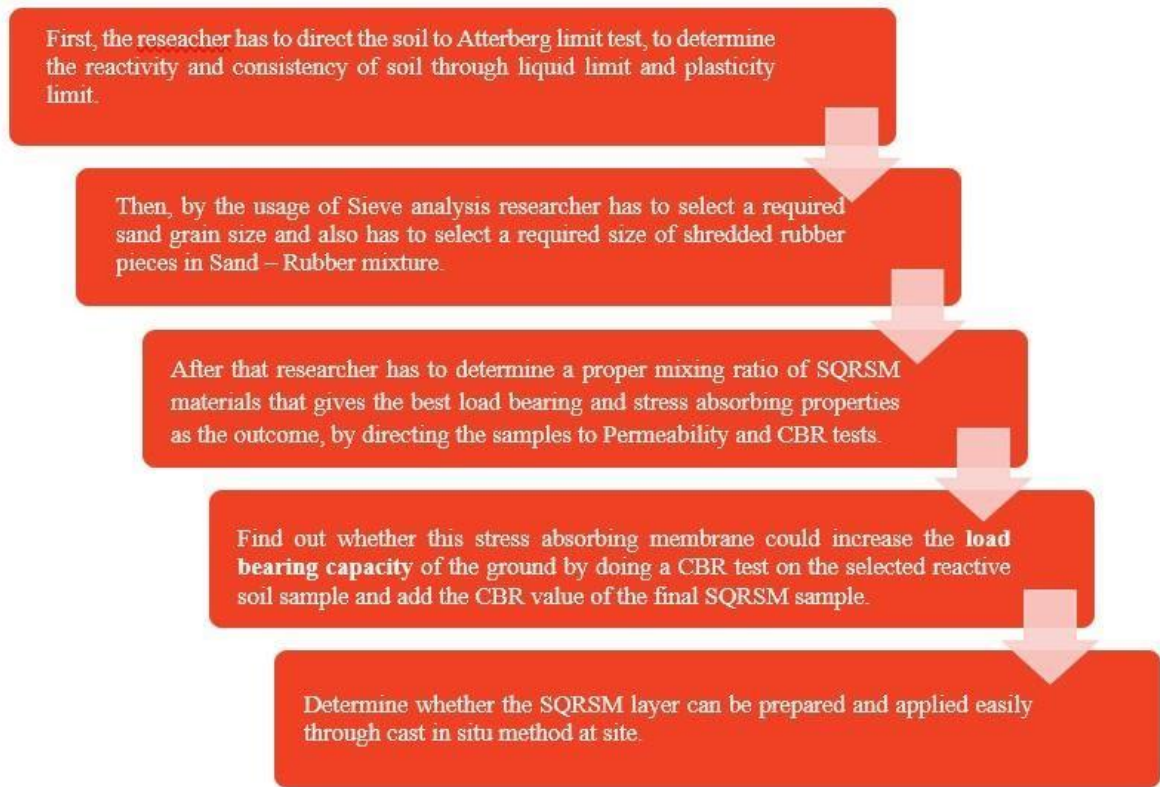


Image 02 – Key steps in methodology

- As the first step, collecting data about the properties of reactive soil types has to be done. After that examining the instabilities that could take place in foundations due to ground movements by climatic impact must be done.
To collect the data about the properties of clay based reactive soil, collection of data on liquid limits, plastic limits and plasticity indexes has to be done by directing reactive soil samples into Atterberg limit test. By this test researcher can determine the required moisture content at which transition between different phases like finegrained clay and silt soil take place.
- As the second step, a required sand grain size and shredded rubber pieces size that to be added to the introduced SQRSM material must be selected through sieve analysis test.
- After that, a proper mixing ratio of materials and which sample gives out the best stress absorbing and load bearing characteristics must be determined by directing each sample to Permeability test and CBR test. After collecting theses data, a proper thickness for this layer must be find out. By this, researcher can determine whether applying the SQRSM layer under the foundation of low-rise building increases the load bearing capacity of the ground.
- At last, it must find out whether this layer could use cast in-situ method in preparation.

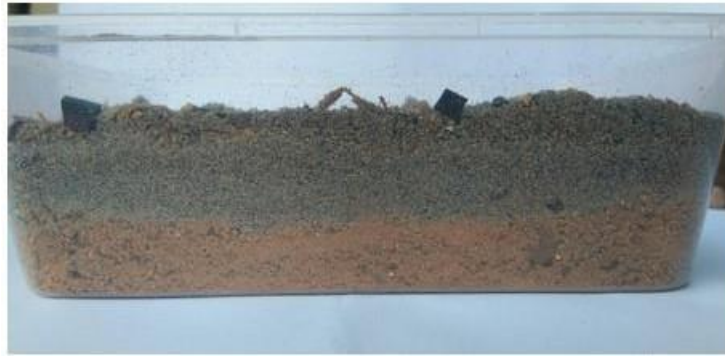


Image 03- Cross sectional view of SQRS layer upon reactive soil

Sample Preparation and Test Procedure

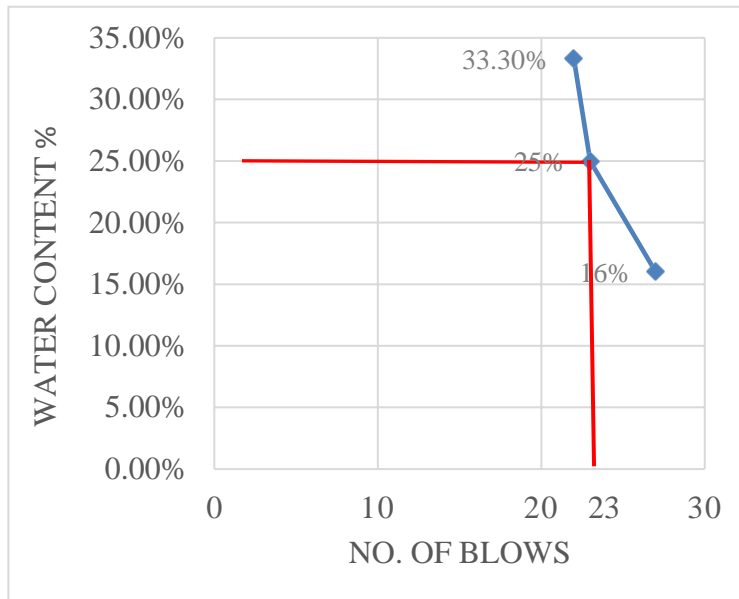
As the first step, researcher has to direct the soil to Atterberg limit test, to determine the reactivity and the consistency of soil through liquid limit and plasticity limit.

106MIC sieved reactive soil sample must be used in Atterberg limit test as per ASTM D 4318-00 (What is the Atterberg Limits Test? - Definition from Trenchlesspedia, 2022). Then the no. of drops from the tests has to be recorded and the 3 samples must be weighed and oven dried for 24 hours.

- Calculated Liquid limit = 20%



Image 04- Atterberg Limit Test



Graph 01 – water content vs no. of blows curve

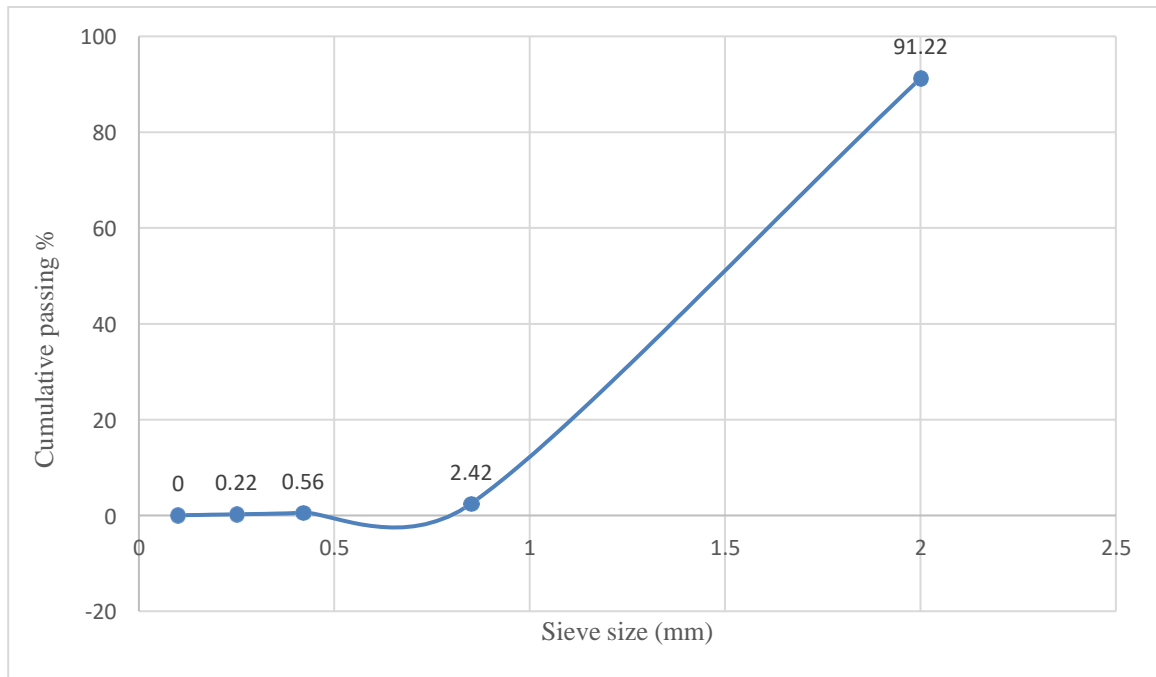
Graph 01 shows the water content of the sample corresponding to the no. of blows and that's 25% by 23 blows. To calculate plastic limit, previous sample from Atterberg limit test that's nearest to 25 blows has to be rolled by hand until it breaks and this has to be weighed and oven dried for 24 hours.

- Calculated Plastic limit = 16%
- Plasticity index = $LL - PL = 4\%$



Image 05 – Plasticity Limit Test

After that a proper sand grain size for SQRSM material has to be found out. Following **Graph 02** is the particle distribution curve of the sand sample that's directed to sieve analysis,



Graph 02 – Particle distribution curve of sieve analysis

The determined sand grain size varies between 0.1mm and 2mm as shown in the graph and this is to be used in SQRSM material.

After that in this research, the researcher has taken the tyre tube crumbs sizes between 4mm-7mm by referring a previous research that's done on "Energy Absorption Capacity and Shear Strength Characteristics of Waste Tire Crumbs and Sand Mixtures" (Anbazhagan and Manohar, 2015).



Image 06 – Tyre Tube Crumbs

Also, an appropriate mixing ratio that gives the best outcome from the SQRSM layer has to be found out. In here, materials have taken by weight percentages and has kept the percentages of Sand and Rubber constant by referring to a previous research that's done on "Energy Absorption Capacity and Shear Strength Characteristics of Waste Tire Crumbs and

Sand Mixtures” (Anbazhagan & Manohar, 2015). Table 01 shows the proper mixing proportions of SQRSM that are selected to use in relevant tests.

Table 01

Sample No.	SAND	QUARRY DUST	RUBBER	SAW DUST
1	37.5%	50%	12.5%	0%
2	37.5%	40%	12.5%	10%
3	37.5%	25%	12.5%	25%
4	37.5%	0%	12.5%	50%

As next step, by directing these samples to permeability test, the researcher can measure the rate of water through these SQRSM layer samples.

In here the 4 samples has directed to Falling Head Permeability test by filling 3 layers of sample in each apparatus. After sealing the apparatus, the water draining time and the readings of the water levels must be taken. Following tables shows the calculated average permeability coefficient values of each 4 samples.

- Diameter of the mold = 100mm
- Length of the mold (L) = 115mm
- Area of the mold (A) = 7853.9mm²
- Diameter of stand pipe = 10mm
- Area of stand pipe (a) = 78.5mm²

$$K = \frac{2.3 \times a \times L \times \log \left(\frac{h_1}{h_2} \right)}{A \times t}$$

Table 02

SAMPLE 01

No . of readings	1	2	3
Initial water level (h ₁) mm	90	70	40
Final water level (h ₂) mm	80	60	30
Time (s)	14.33	20.23	36.10
Coefficient of permeability (k)	0.0094	0.0087	0.0091

Avg. K (mm/s) = 0.009

Table 03

SAMPLE 02

No . of readings	1	2	3
Initial water level (h_1) mm	90	70	40
Final water level (h_2) mm	80	60	30
Time (s)	2.19	2.90	5.36
Coefficient of permeability (k)	0.0617	0.0610	0.0616

Avg. K (mm/s) = 0.06

Table 04

SAMPLE 03

No . of readings	1	2	3
Initial water level (h_1) mm	70	40	20
Final water level (h_2) mm	60	30	10
Time (s)	13.25	26	48.7
Coefficient of permeability (k)	0.0134	0.0127	0.0163

Avg. K (mm/s)= 0.01

Table 05

SAMPLE 04

No . of readings	1	2	3
Initial water level (h_1) mm	90	70	30
Final water level (h_2) mm	80	60	20
Time (s)	1.92	12.35	39.52
Coefficient of permeability (k)	0.0704	0.0143	0.0118

Avg. K (mm/s) = 0.03



Image 07 & 08 – Falling head permeability test

As the next step, a CBR test has been conducted to measure the load bearing strength of the SQRS samples and on reactive soil. When preparing the samples, as the OMC (Optimum moisture content) the value 12% has taken by referring to a previous journal on “Geotechnical engineering” (Cahill, 2022). These selected samples must be mixed with 12% of water by sample weight and it should be added to the apparatus in five layers. Each layer must be compacted with 62 tamping. These compacted samples must be kept for five days to

get saturated. After that, the readings of the CBR test must be taken. Following Table 06 shows the wet densities of the CBR tested samples and Table 07 shows the water content data.



Image 09 & 10- Sample preparation of CBR Test



Image 11 – CBR Testing

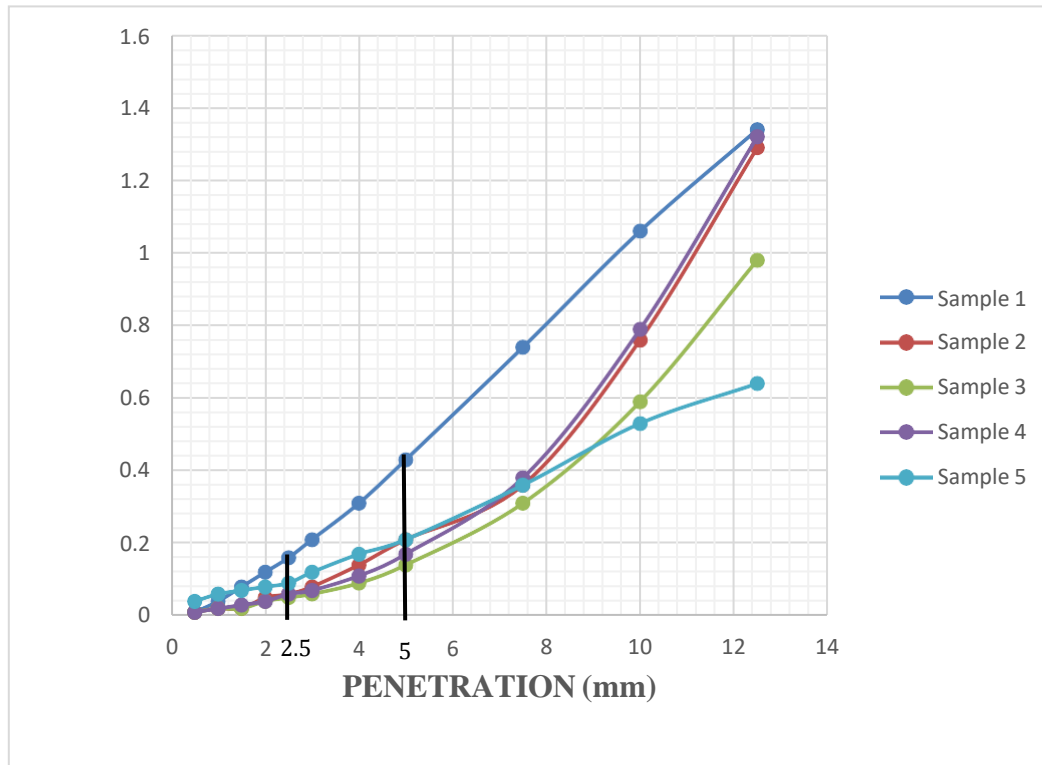
Table 06

Samples	S1	S2	S3	S4	S5
Volume of mould (V) (cm ³)	2359	2359	2359	2359	2359
Weight of mould (w ₁) (g)	4201	4234	4201	4234	4234
Weight of mould + compacted samples (w ₂) (g)	7252	6618	6217.5	5730	7252
Weight of compacted samples (w ₃ = w ₂ -w ₁) (g)	3324	2384	2016.5	1496	3018
Wet density of samples (D _w = w ₃ /V)	1.4	1.0	0.9	0.6	1.3

Table 07

Samples	Water content data									
	S1.1	S1.2	S2.1	S2.2	S3.1	S3.2	S4.1	S4.2	S5.1	S5.2
Weight of container (g)	29	29	30	29	29	30	28	28	28	28
Weight of wet samples + container (g)	39	39	40	39	39	40	38	38	38	38
Weight of dry samples + container (g)	37	37	39	37	36	39	37	35	37	35
Weight of water (g)	2	2	1	2	3	1	1	3	1	3
Weight of dry samples (g)	8	8	9	8	7	9	9	7	9	7
Water content %	25%	25%	11.1%	25%	42.9%	11.1%	11.1%	42.9%	11.1%	42.9%
Dry density of soil (D _d) = 100 x D _w / (100 + w)	1.12	1.12	0.9	1.12	0.63	0.81	0.54	0.42	1.17	0.91

Following Graph 03 shows the Load vs Penetration curves of the 5 samples that are used in CBR tests and CBR values are calculated relevant to 2.5mm penetration.



Graph 03 – Load vs Penetration Curves of samples

Table 08

Sample No.	CBR Value
01	1.2%
02	0.5%
03	0.4%
04	0.5%
05	0.7%

Results & Discussion

Above mentioned data findings assist in proving that, this solution is best for this research problem. After calculating the CBR values, the researcher has selected the sample with highest CBR value as sample 01 with 1.2% of CBR value as most appropriate sample to be used as SQRSM layer. By adding the SQRSM sample 01 on the reactive soil, it gives a total CBR value of 1.9%. Also, when considering the permeability coefficient, the K value of sample01 is lowest, 0.009 mm/s. So, by considering CBR value and permeability coefficient value, itcan be seen that the most suitable SQRSM layer to increase load bearing capacity and stress absorptivity of the reactive soil as SQRSM Sample 01.

When selecting the thickness for this layer, the thickness 0.1B – 0.2B (B = width of building footing) has been selected by referring to previous research on “Response of low- rise

building with geotechnical seismic isolation system” (Dhanya, Boominathan and Banerjee, 2020). This layer can be easily prepared in the construction sites because, the materials can be easily mixed according to the mixing proportions and it can be easily applied with the given thickness. This research agrees with previous literature reviews as mentioned above.

Conclusions

The key findings of this research are the reactivity of the soil and coefficient of permeability. In here, it has been calculated the LL as 20%, PL as 16% and PI as 4%. Also, impermeability test, the K value has been calculated as, 0.009% in S1, 0.06% in S2, 0.03% in S3 and 0.01% in S4. As per the CBR tests, CBR values has been calculated as, 1.2% in S1, 0.5% in S2, 0.4% in S3, 0.5% in S4 and 0.7% in S5. Considering CBR value and permeability coefficient value, it can be seen that the most suitable SQRSM layer as SQRSM Sample 01.

The researcher introduced saw dust as a solution to the problem of expensiveness of quarry dust. This SQRSM sample 01 has 0% of saw dust, and after choosing sample 01 as the final SQRSM layer, this can be also named as “**SQRM**” material.

So as the conclusion for the research problem of foundation instability due to climatic impact, the researcher introduces using of SQRSM layer sample 01 underneath the foundations.

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CHALLENGES IN ADAPTING PASSIVE HOUSE CONCEPT IN SRI LANKA – EXPERIENCED BY SRI LANKAN CONSTRUCTION PROFESSIONALS

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Abstract

The Passive House concept is a sustainable construction philosophy that is a cooperative energy efficiency standard by lowering the building's ecological footprint. Due to numerous disadvantages, the Sri Lankan construction industry is reluctant to adopt green building approaches. Consequently, this paper identifies the difficulties of adopting this approach to the Sri Lankan environment and proposes the most suitable mitigation solutions. To acquire the data, a mixed-methods research strategy was employed. Due to the country's tax structure, the cost of importing the necessary materials will increase, there is a lack of required materials for the passive house concept in Sri Lanka, there is a lack of government support, and there is a lack of political will to implement the passive house concept. Improve the understanding of the PH concept by introducing a new program, promote the PH concept by conducting a public awareness program with the assistance of experts, relevant authorities, and professional organizations, grant duty free concessions, interest free loans for developers to import relevant materials, produce the necessary materials in Sri Lanka, and introduce new guidelines are solutions to the identified issues.

Keywords. Challenges, Passive House, Sri Lanka

Introduction

According to the UN (2018), urbanization will accelerate in the next 30 years. Population expansion has caused urbanization (Wijerathne and Halwatura, 2015). Uncontrolled growth contributes to global warming by destroying natural vegetation to make space for concrete buildings. The author also noted that the heat is weakening and wasting the living environment. More than half of the world's urban, suburban, and rural population causes climate change, therefore cooling needs rise (Keivani, 2009). Climate change and global warming cause environmental, economic, and societal problems, according to Cleugh et al. (2011).

Sustainable development is utilized to create buildings that safeguard the environment throughout their life cycle, according to Amarathunga and Rajapaksha (2016). The Passive House idea reduces a building's ecological footprint through energy efficiency (Dan, et al., 2016). Ultra-low energy buildings use less energy to heat or cool. The Passive House is a low-cost, high-quality building design, according to Figueiredo et al. (2016). According to Feist et al. (2005), the Passive House idea enhances the building so the heating system can be simplified. Passive buildings offer affordable comfort while lowering energy use. Space heating uses 80% less energy than in traditional houses. Total primary energy use has dropped by more than half, including utilities and electrical equipment.

Sri Lanka is proposing a high-rise building construction and massive infrastructure program that ignores environmental concerns, increased energy demand, and climate impacts. (2016) (Amarathunga, Rajapaksa) Sri Lanka spends a lot on energy (Hettige, et al., 2016). Increased

energy demand depletes natural resources and pollutes the ecosystem, according to the author. Given Sri Lanka's geographical and topographical features, adopting to the passive home concept is not a critical activity (Green Building Council Sri Lanka, 2015). This research study intends to assess the challenges adapting passive house concept in Sri Lanka. The study's aim is to demonstrate how crucial it is for Sri Lanka to adopt the passive house concept. The aim of the research was attained gradually. The first stage is to determine the worldwide Passive House scenario. The challenges of implementing the passive house concept in Sri Lanka was next determined and looked into. Finally, an analysis and set of suggestions is provided regarding the existing implementation of the Passive House concept in the Sri Lankan context.

Methodology

Based on the findings of the literature research, a closed-ended questionnaire survey was conducted to determine the disadvantages of using the PH concept in Sri Lanka. As the sample for this study, fifty (50) industrial specialists with understanding of the PH concept in several professional categories such as engineers, quantity surveyors, and architects were chosen and a closed-ended online questionnaire survey was conducted. The data received via questionnaire is analyzed using the "Relative Importance Index."

After analyzing the questionnaire survey data, a series of semi-structured expert interviews were conducted as a qualitative technique to develop mitigation measures for identified problems in applying the PH concept to the Sri Lankan construction industry. As a sample, six construction industry professionals were chosen to participate in semi-structured expert interviews. The demographic information of the interviewees is presented in Table 1 below.

Table 1: Demographic Data of Interview Participants

Code	Profession	Construction Industry Experience	PH Construction Experience
R1	Quantity Surveyor	10 Years	03 Years
R2	Engineer	15 Years	05 Years
R3	Engineer	20 Years	06 Years
R4	Engineer	14 Years	03 Years
R5	Engineer	16 Years	03 Years
R6	Engineer	10 Years	02 Years

Results and Discussion

The analysis of the collected data through the questionnaire survey is presented and discussed in the below section.

Quantitative Data Analysis

The sample for this study consisted of fifty (50) industrial experts from various professional categories, such as engineers, quantity surveyors, and architects, and a closed-ended online questionnaire survey was conducted. With a response rate of 86.00%, 43 questionnaires that

had been improperly filled out were collected. Following Figure 1 are the professional categories of the participants.

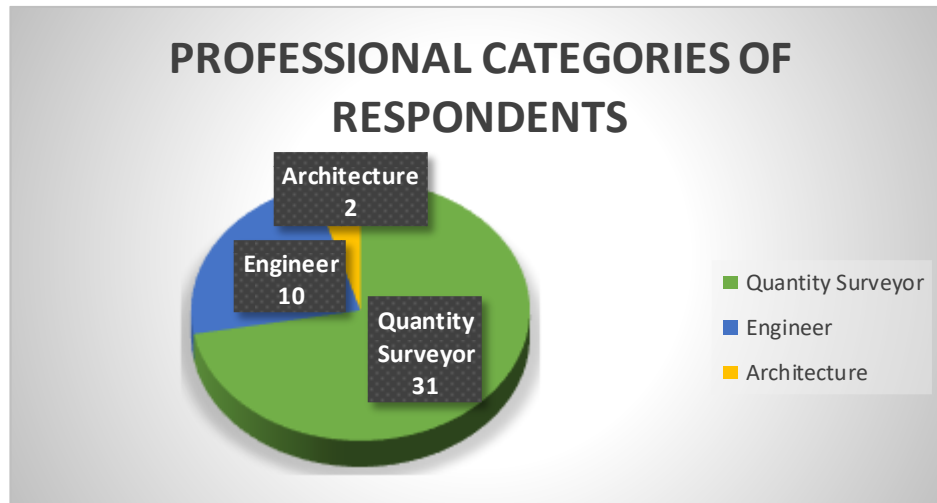


Figure 1: Participants professional categories

The questionnaire study was conducted based on the findings of existing literature regarding the disadvantages of adopting the passive house concept in various nations. The question requested respondents to assess the impact of identified obstacles on the adaptation of the Passive House concept in Sri Lanka. According to the responses collected from respondents, Table 2 presents the following analysis.

Table 2: Drawbacks to adapt to the passive house concept in Sri Lanka

Drawback of using passive house building concept in Sri Lanka	RII Value	Rank	Importance Level
Lack of experts on the field	0.748	01	High-Medium
Lack of knowledge about the Passive House Concept	0.736	02	High-Medium
Attitudes of the People	0.705	03	High-Medium
Poverty of the country	0.679	04	High-Medium
Due to the country's tax structure, the cost of importing the necessary materials will increase	0.657	05	High-Medium
Lack of required material for the PH concept in Sri Lanka	0.619	06	High-Medium
Lack of the support from the Government or political	0.606	07	High-Medium
Misconception and marketing challenges about PH concept	0.588	08	Medium

According to the analysis, the lack of specialists in the field ($RII = 0.748$) is the most significant barrier to adapting the passive house idea in Sri Lanka. In addition, lack of

understanding about the PH concept (RII = 0.736), attitudes of the People (RII = 0.705), and poverty of the country (RII = 0.679) rank second, third, and fourth, respectively. Moreover, due to the country's tax structure, the cost of importing the required materials will rise (RII = 0.657) and was rated fifth. According to the analysis, the absence of required material for the PH concept in Sri Lanka (RII = 0.619) was evaluated as the sixth disadvantage. In addition, the lack of government or political support (RII = 0.606) placed sixth. Misconceptions and marketing difficulties about the PH idea (RII = 0.588) were placed eighth as a disadvantage of using or adapting the PH concept to the Sri Lankan construction industry. Considering the importance level of each identified disadvantage through the literature review and questionnaire survey, it was clear that a lack of experts in the field, a lack of knowledge about the Passive House Concept, the attitudes of the people, and the country's poverty were the most significant. As a result of the country's tax structure, the cost of importing the essential materials will increase. Additionally, the unavailability of required materials for the PH concept in Sri Lanka and the absence of government or political support were highlighted as high-to-medium priority obstacles. In addition, misconceptions and marketing issues about the PH concept were highlighted as a medium-level barrier to the implementation of the PH concept in Sri Lanka.

Selected were factors with an importance level equal to or greater than the high-to-medium level, and a semi-structured expert interview series was undertaken to identify methods for overcoming identified shortcomings.

Qualitative Data Analysis

The analysis of the collected data through the semi-structured expert interview is presented and discussed in the below section.

Solutions for the Identified Drawbacks of Using Passive House building concept in Sri Lanka

- **Lack of experts on the field** - According to all the representatives, providing new diploma, advanced diploma, degree, or postgraduate level programs related to passive home is the major option to overcome this issue. R1 suggested that professional institutes such as Institution of Engineering Sri Lanka (IESL), Institution of Quantity Surveyors in Sri Lanka (IQSSL), and Sri Lanka Institute of Architects (SLIA) conduct continuous professional development (CPD) programs to enhance PH knowledge among existing construction professionals and students. R2 noted that most European countries have already adopted this notion, therefore a few professionals can be sent there for training and to learn about it. R2 suggested "introducing the new concept to clients and making them aware of its benefits" as a way to mitigate this negative.
- **Lack of knowledge about the Passive House Concept** - All the interviewees said it should be included in all construction-related study programs at state universities, private universities, institutions, or technical colleges. R1 claimed that the public "needs general understanding (such as passive house benefits, etc.)". According to R1, R2, R4, and R6, promoting the passive house concept through media and authorities can affect the public. R2 suggested "organize discussions with specialists in the relevant sector to gather fresh technological insights" as another approach.

- **Attitudes of the People** - All the representatives stated another important impediment to adopting PH in Sri Lanka: following adoption, citizens build their own dwellings and buildings. Implementing this approach requires considering their attitudes. R1, R2, and R3 said this problem can be mitigated by presenting the concept to the public. R5 and R6 said to explain similar project experience and client benefits. (Local and foreign projects) Describe long-term savings due to energy efficiency and the compactness of mechanical systems due to their lower design capacity.
- **Poverty of the country** - This is another important drawback of PH in Sri Lanka. In R1, some PH manufacturing must be imported from abroad, which is expensive. Therefore, manufacturing in Sri Lanka is the ideal solution. R4 noted that Sri Lanka has enough resources (manpower, space, etc.) for such productions. R2 and R3 said it's best to go via the Sri Lankan government when importing specific products. To overcome this drawback, R5 suggests conducting research on how to use this concept cost-effectively, providing loan facilities for clients who choose this concept for their buildings, and offering discounts to consumers who choose this concept for their constructions by considering long-term benefits.
- **Due to the country's tax structure** : Due to taxes, importing materials will be more expensive. As a solution for this problem, all participants suggested providing duty-free facilities to clients who choose this design for their buildings.
- **Lack of required material for the PH concept in Sri Lanka:** All participants agree that manufacturing these materials in Sri Lanka is the best solution. R1 added to establish training programs and factories to train people and use worldwide affairs to adopt and train local people. R3 and R5 said to "offer facilities to import material for PH projects" and "search for less expensive alternatives to high-priced materials" as answers.
- **Lack of the support from the Government or political:** All six interviewees stated professional groups including IESL, IQSSL, SLIA, CECB, and SEC should tell government officials about this notion and request financial support to begin early programs. R2 suggested getting loans from other countries to start new ventures using this method.

Conclusion and Recommendations

According to the study, a lack of professionals, knowledge of the Passive House Concept, people's attitudes, and the country's poverty are factors. Due to the country's tax structure, the cost of importing the necessary materials will increase. Lack of required material for the PH concept in Sri Lanka and lack of Government or political support were highlighted as high-medium importance drawbacks. Misconceptions and marketing issues around PH are a medium-level hindrance in Sri Lanka. Accordingly, introducing new diploma, advanced diploma, degree, or postgraduate level programme in relation to passive house concept through professional institutes such as Institution of Engineering Sri Lanka (IESL), Institution of Quantity Surveyors in Sri Lanka (IQSSL), and Sri Lanka Institute of Architects (SLIA) can conduct few continuous professional development (CPD) programmes to enhance knowledge regarding PH concept to existing professionals.

Following the conclusion, recommendations are offered.

- Improve university students' and citizens' knowledge of PH by launching a new program, promoting PH through the media, and implementing awareness programs with the support of specialists, relevant authorities, and professional bodies.
- Offer duty-free imports and interest-free loans to developers.
- Begin PH technology training.
- Start manufacturing in Sri Lanka.
- Create guidelines.

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EVALUATION OF THE GEOTECHNICAL PROPERTIES OF ORGANIC WASTE DUMP SITE IN TERMS OF CONSOLIDATION (CASE STUDY: KARADIYANA DUMPING YARD)

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Abstract

Municipal Solid Waste (MSW) is a major concern in urban areas because they need to be disposed of properly. Therefore, the administration of MSW is a major environmental problem in urban cities. After the collapse of the Meethotamulla garbage dump, there are more concerns about the stability of the other garbage dumps. Karadiyana is one of the major garbage dumps in the Colombo suburb area. This research paper analyses the stability of the MSW landfill of the dumping yard in terms of the coefficient of consolidation which is an analysis of the settlement of the soil landfill. This is because the settlement of a landfill plays a huge role in its stability. The heterogeneity in the MSW landfill determines the geotechnical properties of the landfill a difficult task. 3 samples were taken from the soil landfill and it was subjected to an oedometer test according to ASTM D2345. Using Taylor's method (root time method) the coefficient of consolidation was calculated. Those values were compared with a typical coefficient of consolidation values of stable soil landfill. The results of the coefficient of consolidation were obtained as $7.32 \times 10^{-3} \text{ cm}^2/\text{s}$, $2.41 \times 10^{-3} \text{ cm}^2/\text{s}$, and $6.42 \times 10^{-3} \text{ cm}^2/\text{s}$. The average coefficient of consolidation of the soil landfill of the case study is $5.38 \times 10^{-3} \text{ cm}^2/\text{s}$. These values were found to be in the acceptable range of a stable soil landfill.

Keywords: MSW, Stability, Settlement, Coefficient of Consolidation

Introduction

Solid waste and solid waste management are major aspects of environmental science. The rapid growth of technology and population, as industrialization, has been directly affecting the increase of the generation of MSW. These are categorized into 2 types organic and inorganic wastes. The organic wastes decay and turn into soil landfill and inorganic wastes remain in their natural state for a long time. There are many options to control these inorganic wastes, for example by reusing and recycling the wastes.

Organic MSWs when decayed will turn into soil. So, the increase of organic MSWs and the decaying process which follows will form a soil landfill. This landfill will settle onto the existing land. The new and fresh MSWs are dumped on this landfill which is made of decayed organic wastes. Therefore, the landfill experiences a load (primarily as a sudden impact load) that is similar to the load experienced by structural elements.

The main aspect of this case study is to analyze the stability of the existing solid waste landfill. Because the fresh MSW will be dumped on this existing landfill and therefore the landfill is acting as a load bearing structure. Similar to a foundation. Also, the landfill is not a regular foundation such as a pile foundation or a raft foundation since the solid waste landfill is consist of heterogenous materials which have gone through a decaying process. But still,

the physical, and chemical properties exist. Since a typical foundation structural analysis cannot be performed, to analyze the stability of the soil landfill the structural analysis has to be performed based on soil properties.

The stability or bearing capacity of soil can be determined by its soil properties such as permeability, consolidation, and many other geological properties. In this case study, the consolidation property of the soil landfill has been assessed to determine the stability of the existing MSW landfill.

Similar to an analysis of the structural elements, being knowledgeable on the engineering properties of MSW landfills becomes useful for designing landfills to prevent failures and collapsing. Even though the exact engineering properties of MSW landfills cannot be determined due to the diverse nature of solid wastes, the basic behavior can be identified by these experiments, and therefore the failure modes can be analyzed (Dixon and Jones, 2005).

This report consists of the evaluation of the stability of such landfills in Karadiyana in terms of geotechnical properties plasticity index and consolidation. These properties were determined by proper analysis through the laboratory experiments of the Atterberg limit test and the Oedometer test.

Methodology

Initially, the basic and detailed behavior of the MSW was identified by referring to the literature reviews of the research performed such as peer-reviewed journals, websites, etc. Even though every MSW landfill behaves in its unique way, these peer reviews and journal articles guide how to perform (proper techniques) with the evaluation of the geotechnical properties of a particular landfill which has been chosen as the case study. Further to minimize mistakes.

The undisturbed soil samples of the MSW landfill were extracted at 3 different locations at a depth of 0.5 m.

The plasticity index is analyzed using the Atterberg limit test concerning the test method of BS1377: Part 2:1990.

The consolidation properties of the soil samples are assessed by the oedometer test. The oedometer test is performed as per BS1377: Part 5:1990 and ASTM D2435.

Then summarize the data obtained from the literature reviews and the laboratory experiments these data are analyzed and evaluated by comparing the data obtained from the experiments and the data given in the previous studies. Therefore, the geotechnical properties of the MSW landfill of the case study are assessed, and also the behavior of the landfill is evaluated.

Results and Calculation

Atterberg limit test

Sample 1

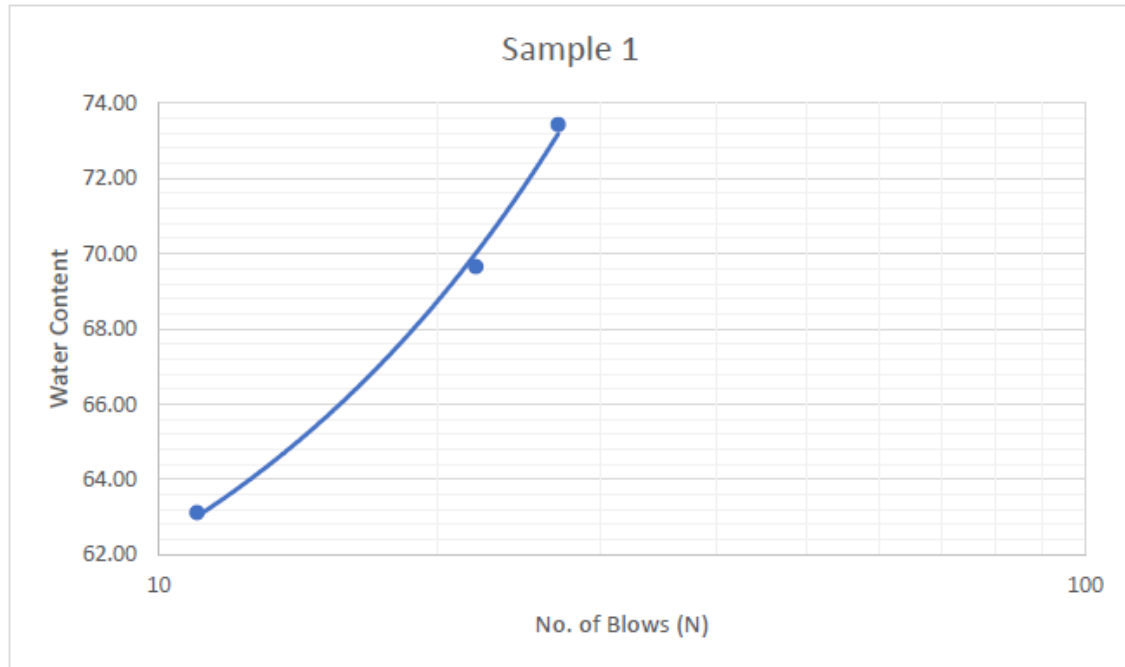


Figure 1: Atterberg limit test graph of sample 1

From the above graph, the Liquid Limit of the soil sample is 72%. The Plasticity Index of the soil sample is -16.61.

Sample 2

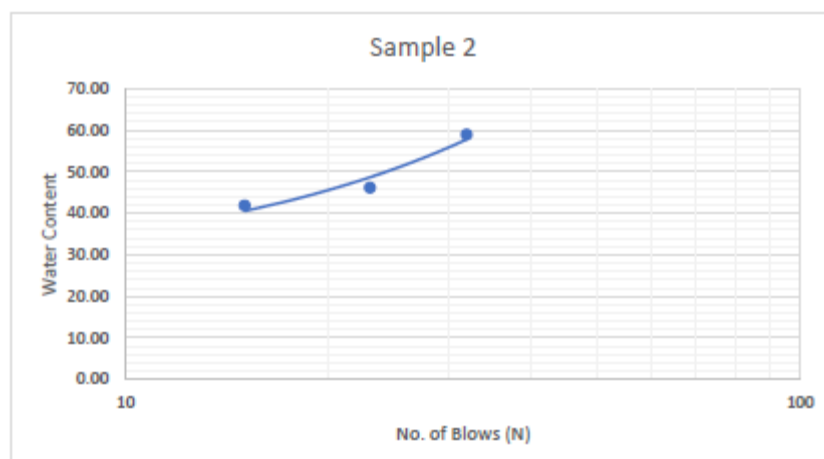


Figure 2: Atterberg limit test graph of sample 2

From the above graph, the Liquid Limit of the soil sample is 50.68%. Therefore, the Plasticity Index of the soil sample is -34.62.

Sample 3

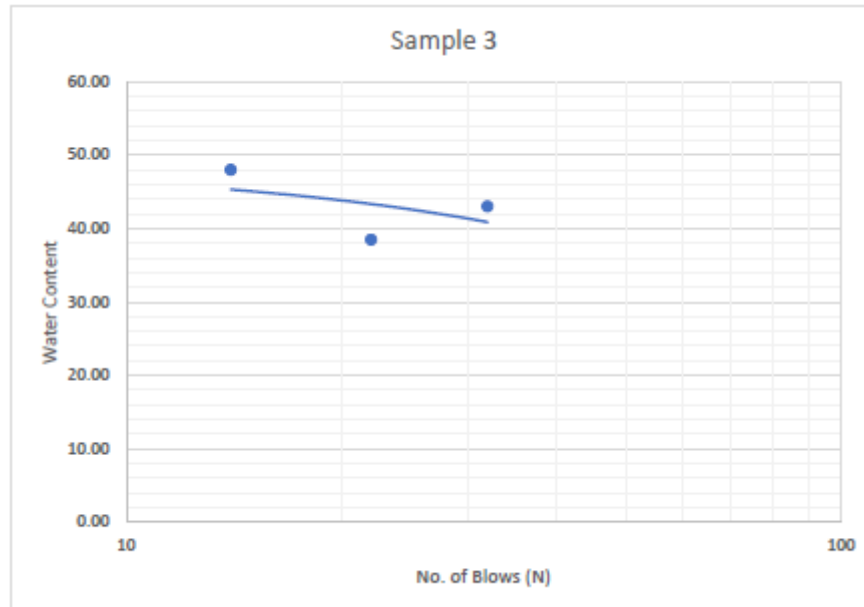


Figure 3: Atterberg limit test graph of sample 3

From the above graph, the Liquid Limit of the soil sample is 42.6%. Therefore, the Plasticity Index of the soil sample is -53.04.

Average Liquid Limit = 55.09%

Average Plastic Limit = 89.85%

Average Plasticity Index = -34.76%

Consolidation Test

Initial sample thickness = 20 mm

Area of the ring = $5.67 \times 10^{-3} m^2$

Diameter of the consolidation ring = 85 mm

Sample 1

Final sample thickness = 18 mm

Applied load = 9.98 kg

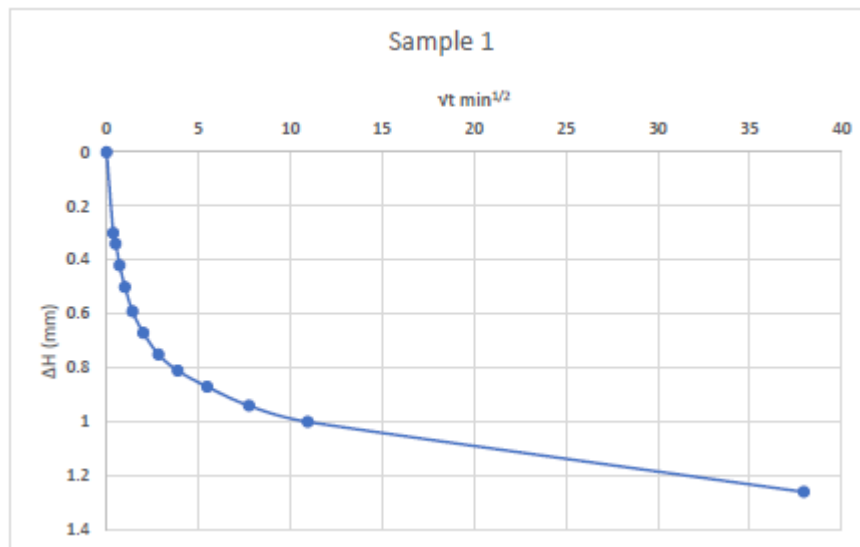


Figure 4: Consolidation curve of sample 1

Coefficient of Consolidation (CV) = $7.32 \times 10^{-3} \text{ cm}^2/\text{s}$

Sample 2

Final sample thickness = 19 mm

Applied load = 14.96 kg

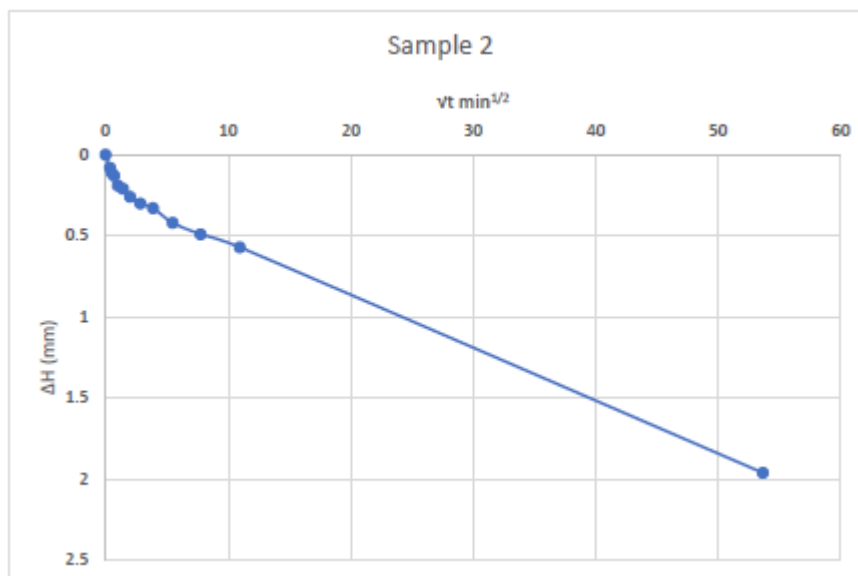


Figure 5: Consolidation curve of sample 2

Coefficient of Consolidation (CV) = $2.41 \times 10^{-3} \text{ cm}^2/\text{s}$

Sample 3

Final sample thickness = 18 mm

Applied load = 14.96 kg

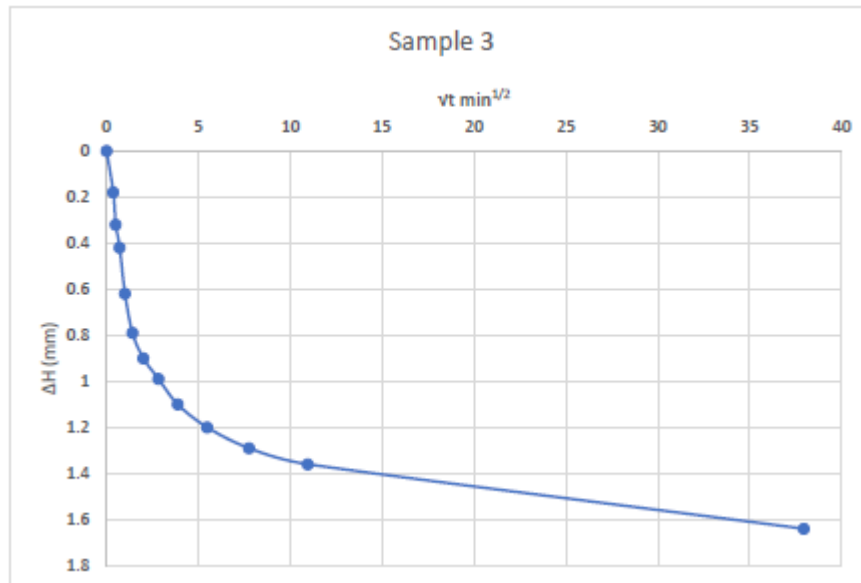


Figure 6: Consolidation curve of sample 3

Coefficient of Consolidation (CV) = $6.42 \times 10^{-3} \text{ cm}^2/\text{s}$

Discussion

MSWs were made naturally by the decaying process of organic solid wastes. There are different kinds of constituents therefore it has a variety of ingredients and due to the decaying process of those ingredients and the additional soil layers that existed to initiate the landfill, the landfill has different and unique geological properties. This makes the assessment and evaluation of the geological properties of an MSW landfill a difficult task (Dixon and Jones, 2005).

The settlement of a particular landfill affects the stability of that landfill immensely. The settlement of a landfill happens in 3 stages which are primary compression, secondary compression, and bio compression. Primary compression happens in an instant due to the self-weight of the fresh MSWs and other external loads such as machinery. Secondary compression is a long-term process. In secondary compression, the settlements occur due to slippages and creep effects. Bio compression is related to the decaying process of the MSWs. The values of the coefficient of consolidation are $7.32 \times 10^{-3} \text{ cm}^2/\text{s}$, $2.41 \times 10^{-3} \text{ cm}^2/\text{s}$, and $6.42 \times 10^{-3} \text{ cm}^2/\text{s}$. By analyzing these values, it can be observed that 2 out of the 3 values are in a close range and the other value is lower than the other two values. This shows the heterogeneity of the MSW. This happens because of the variety of constituents in the landfill. Also, these results show the difficulty in the analysis of the geotechnical properties of an MSW landfill.

A definite range of values cannot be determined for a stable soil landfill. It is because every soil landfill behaves differently. Then the loads acting on the landfill, and the effect of nature on the landfill is different for the different soil landfills. Moreover, the behavior of MSW

landfills is different from that of the natural soil landfill. As stated above, the MSW landfills are made of different materials which have very drastic properties physical, chemical, and geological. Even a minor variation in the constituents can lead to a major deflection of the geotechnical or geological property of the landfill as a whole. Therefore, the geological properties of the MSW landfills cannot be cornered into particular value. There is a value range for the coefficient of consolidation of a stable soil landfill. Therefore, the obtained results should be evaluated separately and on an average basis to estimate the stability of the particular MSW landfill. The results obtained from the tests are compared with the results of such stable soil landfill.

The coefficient of consolidation values is ranged in many varieties. The clay-sand soil landfills have a coefficient of the consolidation value range of 8.6×10^{-9} to 4.4×10^{-6} m²/s. Likewise, the range for the coefficient of consolidation of the sand-bentonite backfiles is from 8.2×10^{-9} to 6.7×10^{-6} m²/s (Yeo, Shackelford, and Evans, 2005). These values are evaluated for stable soil landfill. The coefficient of consolidation can be varied from 6.9×10^{-3} to 1.8×10^{-1} cm²/s, wherein under low pressure, the coefficient of consolidation decreases with the increase of pressure. Soil landfills without nano-bentonite have a coefficient of consolidation of 8.7×10^{-3} cm²/s (Cheng et al., 2020).

When comparing the above coefficient of consolidation values of the stable soil landfill, the coefficient of consolidation of the soil landfill in the case study is obtained as 7.32×10^{-3} cm²/s, 2.41×10^{-3} cm²/s, and 6.42×10^{-3} cm²/s. Therefore, it can be observed that these values are within the range of the values given above. Even in the same landfill, the soil behaves differently to each other in different locations. The average coefficient of consolidation of the soil landfill of the case study is 5.38×10^{-3} cm²/s. Which is also lying at the acceptable level within the above-mentioned range of values.

The coefficient of consolidation values has been analyzed individually and on average to evaluate the stability in a vast range. The analysis shows that the results obtained from the results are in the stable range of values. Therefore, the MSW landfill has a stable behavior in the present situation, when compared with a stable soil landfill. So, the municipal solid landfill of the case study can be considered a stable landfill.

The coefficient of consolidation of the MSW landfill of other areas has a deficit when compared with the values of the case study. The main reason for it is that the age and the nature of landfills differ in many aspects. The soil weathering and underground leachate level affect the geotechnical properties of the soil landfill. The MSW landfill of the case study is fresh. It is basically in the stage of primary compression. Where the landfill experienced a huge amount of settlement in its early stage. This makes the present coefficient of consolidation values differ from the other soil landfills. It is also because the samples were extracted at a level of 0.5 m and above. But when this coefficient of consolidation values is compared with the coefficient of consolidation values obtained from the analysis performed using the soil extracted at a deeper level can show a deficit in the values.

Conclusion

The analysis of the geotechnical properties of an MSW landfill is important for its long-term use. The necessary precaution and action plans can be implemented and executed to maintain the stability of the soil landfill when these geotechnical properties are evaluated. The MSW's landfill is made of different organic elements which are vastly different from each other's properties. Therefore, it is very difficult to analyze the geotechnical properties of the landfill as a whole.

The Atterberg limit test is performed to determine the consistency limit of the landfill. But it can be seen that the values obtained for the plastic limit are not in the range because of the heterogeneity of the soil. The liquid limit of the sample also experiences the same issue and the liquid limit of the soil sample is lying above the acceptable range for an MSW landfill.

The main geotechnical property which is analyzed and evaluated in this paper is the consolidation property. The values obtained for the coefficient of consolidation are 7.32×10^{-3} cm²/s, 2.41×10^{-3} cm²/s, and 6.42×10^{-3} cm²/s, which has an average value of 5.38×10^{-3} cm²/s. The obtained values are compared individually and from an average perspective with the values of stable soil landfill. The coefficient of consolidation values was found to be in the range of those values since this soil landfill of the case study is fresh. When it was compared with the coefficient of consolidation of other MSW landfills it can be seen that the landfill of the case study is undergoing primary compression.

Limitation

There were many limitations during the process of evaluation of the geotechnical properties of the MSW landfill in the case study. First, the soil landfill of the location is fresh and damp. Therefore, the extraction of the soil sample is limited. Access to the other organic waste location is not available since new wastes are being dumped on the existing soil landfill. Therefore, the testing of the samples is limited to a certain extent as stated above. Also, the extraction of samples from different depths was not allowed.

The stability analysis cannot be done based on particular soil properties because the behavior of the soil landfill is different from each other. There is no conclusion that if the coefficient of consolidation of the landfill exceeds this range of values that the particular soil is not stable. It can be both stable and unstable. Therefore, the evaluation is done through comparisons to understand the basic behavior of the soil landfill. If the values are out of the range when it is compared with other values, then it is helpful to focus more on the soil landfill and then perform further in-situ testing and other soil parameter evaluations. Therefore, these kinds of limitations are present in the evaluation of the geotechnical properties of the MSW landfill.

Recommendation

The soil landfill stability is needed to be analyzed with all of the geotechnical properties of the soil such as permeability, hydraulic conductivity, compaction, etc. That provides the exact behavior of the soil landfill. It is recommended that these evaluations be performed once or twice a year because the geotechnical properties of the MSW landfill tend to change immensely.

Both on-site and laboratory testing are recommended to be performed for a complete analysis of the geotechnical properties of the soil landfill.

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STABILITY OF THE WASTE DUMP SOIL IN THE LANDFILL OF KARADIYANA WASTE DUMPING YARD BASED ON THE COEFFICIENT OF PERMEABILITY

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Abstract

Municipal solid waste is a major concern in an urban area because those are need to be disposed of properly. After the collapse of Meethotamulla garbage dump, there arise concern about the stability of the other garbage dumps. Karadiyana is one of the major garbage dumps in Colombo. This research paper analyzes the stability of the MSW landfill of the dumping yard in the means of permeability coefficient which is useful in leachate analysis. Because leachate directly affects the stability of the landfill. Improper leachate can lead to the failure of the landfill because of sliding. By sieve analysis test, the landfill soil has well-graded and the permeability coefficient was determined as of 1.16×10^{-2} cm/s.

Key Words: Municipal Solid Waste (MSW), Coefficient of permeability, Falling head, Fine particles, Particle Size Distribution.

Introduction

Solid waste and management of solid waste is one of the major aspects in environmental science. Rapid growth of the industrialization and also population has resulted in increased generation of municipal solid wastes. Municipal solid waste will turn into soil after decaying. The incoming fresh Municipal waste are dumped over the existing landfills which are mainly the solid waste which were turned into soil.

After the landfill slide occurred in Meethotamulla dumping yard due to failure in stability, stability of Karadiyana garbage dump is investigated since it one of the main garbage dumps in Sri Lanka. Almost 550 tons of Municipal solid waste are dumped per day across 12 acres of site “A” of the yard.

Soil stability can be determined using various properties of soil such as coefficient of permeability, factor safety method through shear strength, ground bearing pressure and so on. In this paper, the stability of the municipal solid waste landfill of Karadiyana garbage dump is analyzed by determining the coefficient of permeability of landfill soil from falling head method, with the aid of PSD graph.

Permeability is also important for designing of the leachate collection, to understand about the internal flow of fluids MSW landfill. It can be used to determine the level of sliding of layers inside the landfill. The MSW landfills have many leachates flowing underneath than the other types of soil landfills. Because these landfills have been formed and compressed naturally. External compression is unlikely to happen. A systemized proper stacking of soil layers is not present in an MSW landfill. Therefore, the permeability factor plays a major part when it comes to the stability of the soil landfill.

Knowledge in engineering properties of MSW landfills are useful in designing purposes for landfill failures and collapsing. Even though the exact engineering properties of MSW landfill are cannot be determine due to heterogeneous nature of solid wastes, the basic

behavior can be identified by these experiments and analyze the failure modes (Dixon and Jones, 2005).

The aim of this research is to identify the stability of the waste dump soil in the yard based on the coefficient of permeability.

The results, analysis and conclusion provided in this paper are based on actual sample collected from the landfill of the Karadiyana dumping yard and the experiments are done under proper supervisions.

Methodology

Collected samples from 6 places which were identified as the critical points of the landfills shown as below figure in a depth of 0.3m – 0.5m.

Particle size distribution is obtained using sieve analysis test.

- Sieves with openings of 4.75mm, 3.35mm, 2mm, 0.425mm, 0.075mm were used.
- 500g of each sample taken for the sieve analysis.

Coefficient of permeability was determined by falling head method.

- Soil sample were sieved using 3.35mm sieve.
- Soil were filled into 75mm diameter mold as 3 layers after compacting each layer.
- Water level of stand pipe were recorded for 1 min duration each at 5 second interval starting from 95cm after soil sample get saturated. Darcy law was used to calculate permeability coefficient.



Figure 1: Collection points of the samples

Results

Table 1: Summarized sieve analysis test results

	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6
Sieve Size	Percentage passed	Percentage passed	Percentage passed	Percentage passed	Percentage passed	Percentage passed
4.75	84	85.1	88.8	86.3	87.1	96
3.35	75.2	77.5	81.9	78.6	78.3	89.9
2	19.2	64.7	69.9	62.9	59.4	77
0.425	0	23.3	14.9	16.1	19.3	24.6
0.075	0	0	0	0	0	0

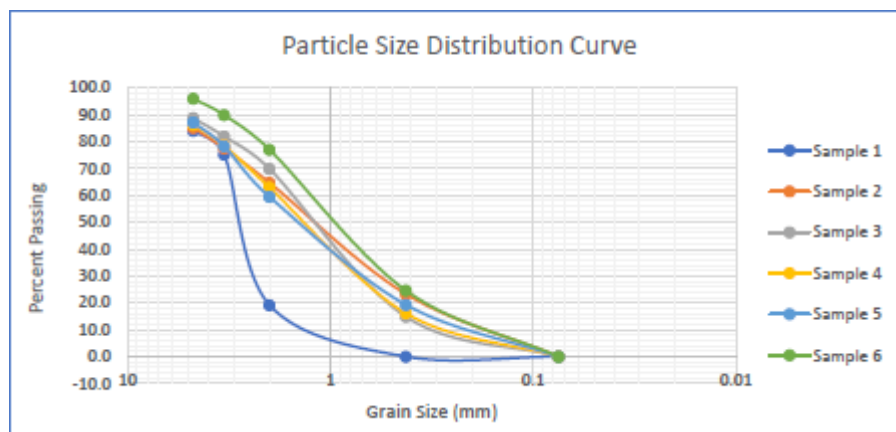


Figure 2: PSD Curve

Table 2: Cu and Cc values

Sample	Cu	Cc
1	21.4	6.2
2	8.1	1.1
3	5.5	1.4
4	6.5	1.4
5	7.9	1.4
6	6.9	1.1
avg.	9.4	2.1

Table 3: Summarized results of falling head permeability test

	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6
Time	$\ln (h_0/h_t)$	$\ln (h_0/h_t)$	$\ln (h_0/h_t)$	$\ln (h_0/h_t)$	$\ln (h_0/h_t)$	$\ln (h_0/h_t)$
0	0.000	0.000	0.000	0.000	0.000	0.000
5	0.044	0.170	0.150	0.223	0.202	0.181
10	0.086	0.279	0.302	0.414	0.279	0.388
15	0.130	0.414	0.441	0.555	0.602	0.586
20	0.155	0.540	0.571	0.684	0.775	0.702
25	0.208	0.634	0.702	0.765	0.927	0.794
30	0.244	0.738	0.813	0.843	1.056	0.833
35	0.276	0.833	0.949	0.916	1.190	0.884
40	0.314	0.895	1.056	0.984	1.279	0.916
45	0.348	0.984	1.148	1.056	1.395	0.961
50	0.274	1.007	1.219	1.121	1.487	1.007
55	0.426	1.056	1.279	1.167	1.546	1.044
60	0.467	1.069	1.327	1.219	1.631	1.081

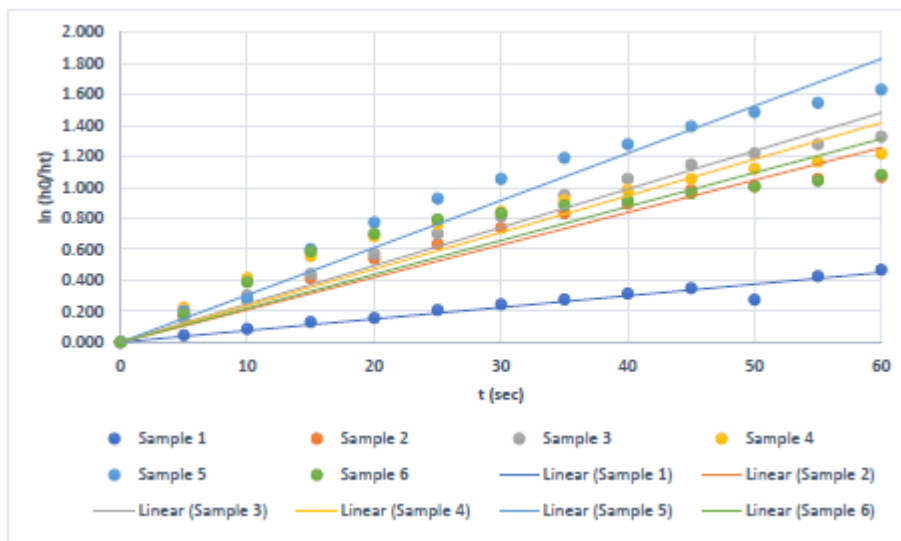


Figure 3: Permeability best fit graph

Table 4: Calculated coefficient of permeability for each sample

Sample	1	2	3	4	5	6	avg.
k (cm/s)	0.00403	0.011235	0.01328	0.01269	0.016396	0.01177	0.01157

Discussion

A study of the physical characteristics of municipal solid waste is done to understand the behavior of the stability of the municipal solid waste landfill. The maximum of municipal solid waste retained was on 0.425mm sieve. The Cu and Cc values of the sample as shown in table 2, the average of all the sample shows 9.4 and 2.1 respectively. For a well graded soil, Cu value should be greater than 10 and Cc value should lie between 1 and 3. The Cu value of the sample is approximately in the range of well graded soil type similarly the Cc value lies within the required range. This indicates that the samples are well graded and there is minimum presence of clay particle. As shown in figure 2, except sample 1 all the other sample obey a similar particle size distribution curve.

Coefficient of permeability is one of the parameters used to analyze the stability of a landfill. Figure 3 shows the best fit graph drawn for the results in table 3 which were obtained from falling head permeability test. Similar to particle size distribution curve, apart from sample 1, other samples are lies within same range.

Coefficient of permeability values for each sample and the average value is given by table 4. It can be seen that municipal solid waste soil sample in the landfill has an average coefficient of 1.16×10^{-2} cm/s. The coefficient of permeability of MSW in landfills calculated by falling head is in the range of 4.7×10^{-4} – 1.2×10^{-2} cm/s (Yang et al., 2015). The experimental values are in the particular range.

Permeability coefficient of the sample 1 is 4.03×10^{-3} cm/s. This sample is the soil from the bottom of the slope, the average k values of the soil which were taken from the upper part of the land fill where the new wastes are to be dumped is 1.32×10^{-2} cm/s. Permeability coefficient of the sample 1 is 4.03×10^{-3} cm/s. This sample is the soil from the bottom of the slope, the average k values of the soil which were taken from the upper part of the land fill where the new wastes are to be dumped is 1.32×10^{-2} cm/s.

When comparing both particle distribution curve (figure 2) and the permeability best fit graph (figure 3), except soil sample 1, other soil sample behave in similar manner. It is because sample 1 was taken at the lowest possible place in the landfill where it contains many heterogeneous materials.

The characteristic of the leachate of the landfill can be determined using the permeability coefficient. The study on the quantity of the leachate is important because it can directly affect the slope stability.

There are several ways an MSW landfill could fail. For example, due to exceeding bearing capacity, poor soil type, slipping of soil layers. By investigating the leachate quantity of the landfill slope by permeability coefficient, the seepage characteristics of the soil layer can be determined. Since the permeability coefficient decreases with the increase of depth. Landfill instability happens when there is high leachate level.

Regular filling of solid wastes makes the existing soil on landfill compacted. Due to that, horizontal layers are formed, and it results with greater horizontal permeability than vertical permeability.

Conclusion

Sieve analysis test was done to determine the soil type of the MSW landfill in Karadiyana dumping yard. From the obtained results, the soil type is almost within the range of well graded soil.

Upon the permeability, permeability of the MSW landfill soil is lies in the range shown in the provided references. The stability of the landfill cannot be exactly determined only through coefficient of permeability. As per the results the permeability coefficient of the Karadiyana dumping yard landfill area where the new waste is placed is in a stable condition. But these properties could drastically change if there is no proper garbage dumping system.

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BIM ORIGINATED IDEAL LIFE CYCLE COST OF SUSTAINABLE DESIGN: A REVIEW

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Abstract

The environmental issues have been a global disquiet for the past decade that persuaded the need of sustainable construction. To achieve high sustainable enactment in the construction industry, the balance between the economic, environmental and social criteria has to be met. Building Information Modeling (BIM) is used in expediting design process to obtain the preeminent sustainable design during the early phases of construction. Architecture, Engineering and Construction (AEC) trade is attentive while being concerned about both BIM and sustainability. Life Cycle Cost (LCC) and Life Cycle Assessment (LCA) assess the economic as well as the green enactment used in project, which helps in selecting the most suitable sustainable design which is developed using BIM. Nevertheless, the setting up and application of such has yet to be effectively accomplished. This paper demonstrates a critical assessment of prevailing writings and methodologies to value the benefits of using BIM integrated tools to calculate and analyse the cost and to reduce the LCC while developing sustainable designs during the primary stages of a building development. Further, the paper reviews current drawbacks in accomplishing such processes and the advantages and the impact on the LCC in accomplishing the same. The critical review recognized that having a base case in developing alternative designs will be appropriate while gathering the cost components for LCC analysis in the fields such as: Project costs, Utility costs, Maintenance costs, Service costs, Remodelling costs, End-of-life costs and following the LCC concepts like: Time value of money, Inflation, Discount, Escalation, and Study life will enhance the selection of the best sustainable design. The strengths and limitations of BIM integrated tools and each of the techniques used in achieving will be further reviewed and discussed. The paper concludes that with effective management and innovative thinking along with proper BIM integrated tools in analysing the LCC will give a positive impact on the project and the environment.

Keywords: *Life Cycle Cost, Building Information Modeling, Sustainable Design, Innovation, Integration*

Introduction

The construction sector is known as the highest waste producer. Construction absorbs energy, materials, and financial assets throughout its life cycle, affecting the environment and economy (Kovacic and Zoller, 2015). Consuming 12% of water and 40% of energy it consumes a total of 32% of the total resources globally (Soust-Verdaguer et al., 2017). As per recent studies, the need for sustainable buildings with low environmental impact is developing as the human health and environmental benefits have been extensively recognized (Azhar et al., 2011). Ecological and financial costs including disposal costs throughout the mean life of a building is determined through the existing methods as the LCC and LCA

(Dhillon, 2013). However, where both LCA and LCC are executed at the same time by the same person, using same databases and software in a unified way, the differences between the tools will cater a limit in terms of competence, clarity and reproducibility (Oduyemi and Okoroh, 2016). Hence the necessity has risen to enfold the BIM method as it covers the architecture, information technology and construction.

BIM is a set of correlating approaches, techniques and abilities that generates a framework to monitor the dynamic building design and demonstrate data in a digital blueprint during the course of the building's life-cycle. BIM provides an innovative and integrated working platform which improves the sustainability and the efficiency during the course of the project life cycle while bringing technical assistances to the development process (Elmualim and Gilder, 2014; Underwood, 2009). Regardless of the fields, the three vital elements, such as, environmental, social and economic has become metrics in contribution to measure the level of sustainability (Khan et al., 2016). It is verified that BIM increases the life-cycle cost saving of a construction project. Lu et al. (2014), concluded that by means of a financial value analysis a budget redeemable of 6.92% accomplished which was done in a model BIM development. Guo and Wei (2016), on the other hand, to implement additional inclusive information for optimal design selection, exploited BIM with an energy-simulation method to demeanour an energy-consumption analysis.

Environmental sustainability improves its quality of life by mitigating the amount of greenhouse gas emissions that enter the atmosphere. Evaluating the airflow of a building's whole ecosystem, BIM can develop the spatial design of a building (Bonenberg and Wei, 2015; Filho and Brandli, 2016). BIM can similarly be used to increase energy recreation and assess potential opposing green effects in the circumstance of sustainable valuation (Al-Ghamdi and Bilec, 2015). Integrated accession of above features facilitates sustainability concerns to be preserved as a complex system rather than ponder on the "cause and effect" separately (Azapagic and Perdan, 2014). However, there is not so far a complete review of BIM strategies or guiding principles and BIM practices for sustainability as a whole (Chong et al., 2017).

Based on the above discussions, this paper reviews the application of the LCC and LCA in a construction project, the scope of integration of BIM and sustainability and also looks at the drawbacks affecting a full-fledged integration.

Methodology

The main objective of this paper is to identify the value and benefits of using BIM integrated tools to calculate and analyse the cost and to reduce the LCC while developing sustainable designs during the primary stages of a building development. Therefore, the research question is: What are the obstacles hindering the integration of BIM and LCC to develop sustainable designs? In order to work out an accurate answer for the research question, this paper adopts a qualitative extensive literature review approach. It explores the subject by collecting, investigating and analysing unstructured, detailed and rich-in content data. According to Snyder (2019), systematic reviews are the most effective for addressing a particular definite research question between the different review types, due to its strict search strategy requirements. A comprehensive preliminary literature survey was carried out based on

journals, books, articles, conference proceeding, government publications, and previous research investigations. No limitations were set to specific source, authors, or origins, to ensure maximum coverage of the topic, while publish dates were mostly taken from the last ten to fifteen years to avoid outdated work. A qualitative content analysis was then carried out to extract and identify the full set of challenges encountered during the application of the models, proposed within these papers. These are directly concluded through reported limitations, or indirectly through authors inductive reasoning and interpretation. The challenges and findings are then classified into a number of categories and subcategories. This information will be essential for drawing some statistical observations that might be employed to provide more insights into the topic trend over the past years.

Role of BIM, Sustainable Design, LCC and LCA in the AEC Industry

At present, the practice of BIM for Sustainable design in AEC industry is developing internationally. AEC industry must meet demand for accessible, secure, and healthy new and rehabilitated facilities while minimizing their impact on society, wealth, and environment (Jalaei and Jrade, 2015). However, the existing improvement of BIM for sustainability is yet heavily focused on a specific feature. For instance, as per social sustainability a unified BIM-based innovative electronic procurement method was suggested for project stakeholders' teamwork (Jardim-Goncalves and Grilo, 2010). In terms of economic sustainability, a BIM-based cost-estimating method was generated to systematize the bill of quantities making (Plebankiewicz et al., 2015). To magnify the environmental aspect a detailed review of green BIM was provided by Wong and Zhou (2015). Furthermore, Chong et al. (2017), briefly described a primary outline of BIM for future sustainable improvement.

The optimization potential during the beginning of a building development is nearly immeasurable at a comparatively insignificant rate, yet, during the project life its performance for future is immeasurable. According to Bogenstätter (2000), early design costs are 80% operational and environmental. In the final planning stages of a project, change possibility drops rapidly and costs rise (See Figure 01). Working expenses exceed building charges by a third, although the ratios, precise exceeding points, and main to subsequent expenses depend on the structure's quality, type, intensity, and lifespan. Combined forecasting, building cost, and development could lower the costs listed. Initial valuation of functioning redeemable possibilities or collation and assessment is allowed by the application of LCC analysis (Kovacic and Zoller, 2015). AEC industry struggles with lack of information, tools, and data during early planning phases (Wang et al., 2002). Therefore, planning tools are required by investors and planners, whom shall facilitate replication and development of building life cost at present in the beginning stages (pre-design) of a project (Kovacic and Zoller, 2015).

If the entire industry embraces BIM technology and adheres to construction norms, an optimal life cycle cost can be achieved despite the hurdles. Therefore, it is best for all stakeholders in a construction project to perfect the required techniques to ensure the future buildings are carbon neutral (Lai et al., 2010).

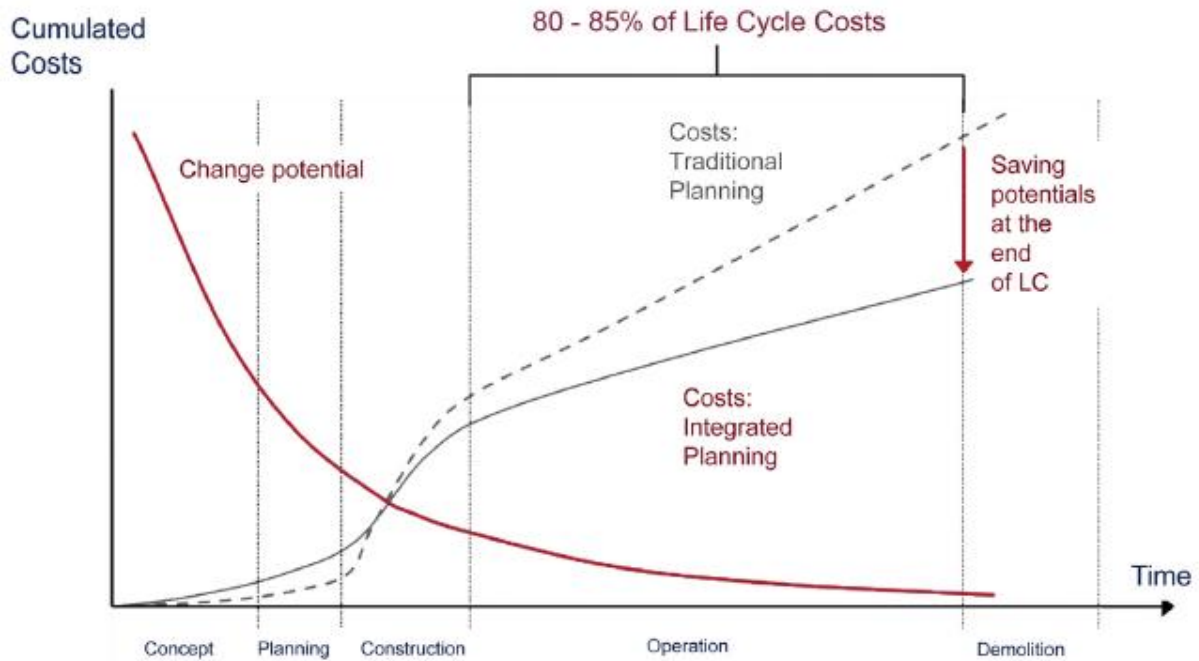


Figure 1 - Cost Increase vs Changes Prospective for the Duration of the Project Plan Life of the Project

LCC in Construction Projects

Evaluation of the cost effectiveness of the substitute design schemes is calculated using LCC considering the probable primary and functioning expenses which will occur during a relative time period. The emerging trend for “value for money” along with the importance towards sustainability aspects, operational and maintenance costs of buildings made LCC calculations become more essential in construction projects (Gundes, 2016). According to Flanagan and Jewell (2004), in a typical office building during a life span of 25 years the total life cost will be three times the initial cost of the building itself. However, absence of consistent information on rate, performance expenses and insecurity in the forecast of yet to come expenses are seen as existing problems. It is considered that in the assortment of an applicable period, factors such as the design life, projected renovation periods and economic interest are important. Consulting (2007), also points out that the decisions taken when selecting the examination time and the price cut amount have to be very cautious as it has a direct impact on the LCC analysis outcomes and is closely allied. However, the suggested procedure evaluate the financial effects of scheme substitutes recognized upon base of feasible valuations using LCC and does not fully integrate with LCA (Gundes, 2016).

Project utility and maintenance costs are several components that incur at different stages of a construction project life cycle that involve in LCC calculations as concerned by the cost indicators. However, it is used to select the design including lowest cost of life referring to the relevant design issues and to select the optimal design. The estimation of the building life anticipation is an important part in LCC apart from the discounting, escalation and inflation factors (Gundes, 2016). Ashworth (2004), claims that obsolescence factor causes the indecisions of a construction’s life expectancy rather than deterioration factor. Even though, it is expected to some magnitude to replicate the eco-friendly and societal weight of

construction structures by the total cost consumption of resources in LCC calculations, the economic life itself does not reflect a buildings total life span. The environmental span of a building is covered by the LCA (Gundes, 2016).

Integrated Approach to Assess Sustainability

Integration Through LCC and LCA

As there are differences between the purpose, the methodology and the scope of the methods even though they discourse the same life span thought of the project these are yet different. Norris (2001), states the importance of integrating the economic and environmental tools by three reasons. First, the economic factors should be considered thoroughly as the significance use of LCA is limited in decision making as the required resources for production always remain different. Second, an exclusive analysis on the economic factor is insufficient as there are hidden costs which come across only throughout the entire project life cycle. Third, when considering alternative products, the inter relation amongst environmentally friendly and financial recitals and the trade-offs and their involvement cannot be accounted if the procedures are used separately (Gillian et al., 2009). Thereby, the need to have an integrated structure is definite. Yet, a number of disquiets come to the forefront when integrating LCC with LCA type of methodologies. This complex situation arises due to the different expressions, agenda, purpose and the deviousness instructions. Such as, the data requirements, addressed life cycle, units and the timing of flows (Heijungs et al., 2013).

While some researchers supported the fact that the environmentally friendly expenses will be diverted into a format that can be applied into the LCC analysis which is derived as in monetary values and thus the two tools could be integrated to calculate the sustainability of a particular construction project (Carlsson, 2005), some researchers stated that the combination is not possible and examined the indicators independently (Heijungs et al., 2013). The following formula, built on previous works is a response by Kloepffer (2008), to the integration of Social Life Cycle Analysis (SLCA), LCC and LCA. Formula 1 shows that LCSA calculations incorporate the LCA, LCC, and SLCA.

$$\text{Life Cycle Sustainability Analysis (LCSA)} = \text{SLCA} + \text{LCA} + \text{LCC} \quad (1)$$

The impacts on the stakeholders in a construction project is noted as the social dimension in the valuation of the sustainability process. As the study on SLCA is new to the industry many challenges could be observed in many perspectives and some may concern the selection of the social criteria and the necessity for area focused precise information (Marzia et al., 2010). Numerous studies are conducted to examine the way these dynamics could be involved in LCA scheming. Nevertheless Zamagni (2012), points out possible encounters faced in regard to SLCA and derived that future works are required to develop the calculations. Interpretation and communication of LCSA results are more challenging as it not only face challenges to the separate calculations done in the other dimensions of sustainability, but with the overreaching assessments different trade-offs were obtained while analysing with different life cycle tools and also of the variety of purposes in relation with the tools that were obtained by the dimensions (Gundes, 2016).

More recently, a European research project introduced a model namely Life Cycle Costing and Assessment (LCC+A) that integrates environmental and financial calculations in a construction project. The model with the two dimensional plot for cost and environmental impact combine different metrics together (Gundes, 2016). The variety of results are conveyed in blotches because the model will then recognize the limitations about the future related data in such a way that the typical way of plotting is not necessary. Simply the model is created to target and report the ambiguity in the upcoming future financial and eco-friendly variables. Accordingly, the substitute designs can be matched with each other without the necessity of being combined keen on a mutual solitary quota (Fawcett et al., 2012).

BIM-LCA Integration

LCA is most commonly identified as an environmental impact assessing tool. LCA represents the building life cycle as a system which consist of unit processes which identifies the input and output flows respectively (Buyle et al., 2014). LCA has been recognized as a strategy to minimize the consumption of energy and the relevant impacts by the environment of construction projects (Soust-Verdaguer et al., 2017). Biases about the complication and the time-consuming factors in application of LCA were detected (Basbagill et al., 2013). However, recent literature points out the advantages of integration of BIM and LCA (Soust-Verdaguer et al., 2017). Kreiner et al. (2015), developed a methodology and stated that integration of LCA and BIM as a path to improve sustainability in buildings. Furthermore, Soust-Verdaguer et al. (2017), showed the importance of BIM in LCA for typical family houses. BIM and LCA integration decrease time and improves environmental performance from the start of a building project, however theoretical and practical issues such as software integration, data requirements, stakeholder involvement, and lack of standardised design processes have arisen (Hollberg and Ruth, 2016).

Integration of BIM in Sustainable Design

During the recent years BIM has got the undivided attention and is equally useful in carrying out sustainable building designs. While providing important data for design projects BIM also involves in functions for building performance analysis. Therefore, most of the researches and studies found and carried out are more methodological in its own nature (Liu et al., 2015). BIM helps designers predict and fix construction scheme flaws before a major project failure. Thus, BIM is a typical tool for assessing sustainable building design. It simulates building projects in the visible environment and integrates geometry, 3-D relationships, topographical statistics, and construction element material items (Hoes et al., 2009). It offers a capacity to do the mock-up to confirm the enactment of design projects and allows designers to develop their designs and choose the optimal one (Oduyemi and Okoroh, 2016).

Challenges Facing the Enactment of BIM Towards Sustainable Design

The practice of BIM in ecological scheme needs substantial preparation. Similar to numerous software programmes, there are enormous costs related with purchasing, licensing and training (Oduyemi and Okoroh, 2016). A contractor, in order to use BIM in the project may need to upgrade the computer system effectively. Also, as the levels of expertise differ necessary training should be provided in all relevant areas before implementing BIM to the project (Wang et al., 2015). Furthermore, BIM entails extra determination at the beginning of

a sustainable design project (McAdam, 2010). When BIM is used, team work and collaboration between all stakeholders is vital (Anil and Prateek, 2013). Although, quick changes in the building model could be done as an advantage using BIM it also can interrupt the construction process and procurement in ordering items and material that require a long-time span (Oduyemi and Okoroh, 2016).

Conclusion

There is no qualm that the construction industry plays a main role in sustainable improvement of countries. Today, a diversity of life cycle concentrated practices with altered devotions are offered for evaluating the diverse magnitudes of sustainability. This paper specifies the necessity to support in the combination of BIM-LCA and LCC towards accomplishing a sustainable design. However, the need for a systematic procedure to work out calculations related to the integration of sustainability valuation tools such as social, financial and environmentally friendly is still a question to be answered. Somehow, the question attracted many researches to study in this regard within the past years. Thereby several methods are published in relate to the specific areas.

BIM has the capability to become the foremost technology of the construction industry, and it is in the attention of most companies to start their adaptation towards its developments and in the direction of sustainability. The more BIM is used, and the more data that are gathered and kept in the course of the life of a project, the more reimbursements can be leveraged. As users gain expertise with BIM, they will progressively benefit from the skill's potential and push for new ways to gain advantages in all areas of the project. BIM standards must guarantee teamwork and continuing assurance among the partakers. The connection of various stakeholders bases organizational complications and enforces the need for constant highlighting of the “win-win” result for the partakers over and above any distinct and conflicting interests. Active management and management of the BIM standard roll-out is therefore essential for marketing and for spreading information, so that the values become broadly known and acknowledged in the industry.

The paper shows that before the technology takes over the construction industry during the design stages which allows to exchange data between the evaluating tools in the near future yet there is a path to go. The arrangement of diverse tools using BIM models for evaluating and quantification of building materials, environmental databases, and LCA tools, has the benefit of containing more ecological impact groups and the drawback of the necessity of more physically edited data. Therefore, it is suggested for a whole LCA solicitation through early stages of design, permitting the end handler to select material features, transport distances, and construction methods, etc. The combination of BIM-LCA should support designers and engineers to gain quick and dependable results about the environmental performance of buildings, since the early stages of design. Thus, one of the most important challenges for them is to identify and recognize the developments involved during the building life span. In order to attain the full potential of that, end users must have additional control over processes and appearances of building materials through the life cycle.

It is as well understood that the combination of BIM-LCA can decrease the determinations in data input and can also be smeared as a useful means to relate building materials and energy

scenarios, even though several restrictions were also noticed in order to automatize the application in the AEC sector. The difficulty of connecting each material and building section with the unit methods through the life cycle of the construction is noticed as a major difficulty. Therefore, to automatize data conversation, it is essential to familiarize material properties and the bill of material quantities from BIM software to LCA technique data arrangement. Moreover, data source interoperability should safeguard the local picture of data and the building features, without challenging so much work of end users.

However, as the new methodologies have yet to be practiced further, the efforts for new focus should be regarding the difficulties faced by the current practices to making a greater impact. Finding the required data from the local areas or the governments is the next issue face during the early stages of the project. Although, there is a massive need for a national database still the expansion of the available data should be done. Applications to the current tools need more published examples as the communication between the derived results from the valuations is yet unresolved. Overall, the raise of stakeholder management research appears to be vital for getting organized in diverse areas of proficiency that is needed in sustainability valuations. It also indicates further research concentrating on the use of user-friendly platforms that can compromise better guarantees to obtain quick, illustrative and comparable results.

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ENGINEERING

A PROTOTYPE OF MICROCONTROLLER-BASED, LOW-COST ELECTRIC-POWERED WHEELCHAIR

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Abstract

An electric-powered wheelchair (EPW) equipped with microcontroller technology has been designed to afford elderly and physically challenged individuals with a safe and independent means of travel. The wheelchair is equipped with a joystick for ease of control and a rear-facing ultrasonic proximity sensor to prevent collisions with both stationary and moving objects. The EPW is powered by a 140W (0.19 HP) 12V DC motor and also features a buzzer to alert individuals in its path, particularly for those with an inaudible voice. This EPW aims to grant mobility and independence, reducing reliance on external aid, through its general features.

Keywords: Wheelchair, Joystick, ATMEGA328p, Overcharge-Controller, Ultrasonic-Braking

Introduction

The inadequate availability of wheelchairs in developing nations, with only 10% access for those in need, according to World Health Organization (WHO, 2011) data, significantly lags behind the 95% access in developed nations. This results in a deficit of 109.62 million individuals without access to wheelchairs. In Sri Lanka, the high cost of importing EPWs, ranging from \$485 to \$23,400, exacerbates financial difficulties, negative socio-economic consequences and employment challenges for people with disabilities (PWDs), according to World Bank (Ivers, 2022). This study aims to mitigate reliance on traditional wheelchairs, particularly for those with limited upper body strength, and to address the resultant limitations in independence and self-esteem, as well as the physical strain on caregivers. The research endeavors to differentiate itself from current market offerings by focusing on the utilization of cost-effective materials, development of a functional and user-friendly design, and localization of EPW prototype production. These efforts aim to improve the quality of life and reduce dependence for physically disabled individuals in Sri Lanka. This study serves as a foundational step towards the eventual creation of a more comprehensive, full-fledged model based on its findings.

Methodology

This project utilizes an ultrasonic obstacle detection system, which prevents the EPW from continuing its reverse movement when an obstacle is detected (Tulaskar, et al., 2021). A power supply unit, consisting of a voltage regulator and deep-cycle battery, provides regulated power to various system components. A battery charging unit, incorporating a charge controller and rectifier, converts 240V AC mains power into 15V DC to charge the 12V battery. A peripheral unit equipped with a horn and LED light functions as a signaling

and lighting system, while a microcontroller serves as the central processing unit, controlling all systems in the EPW (Stephen, et al., 2015).

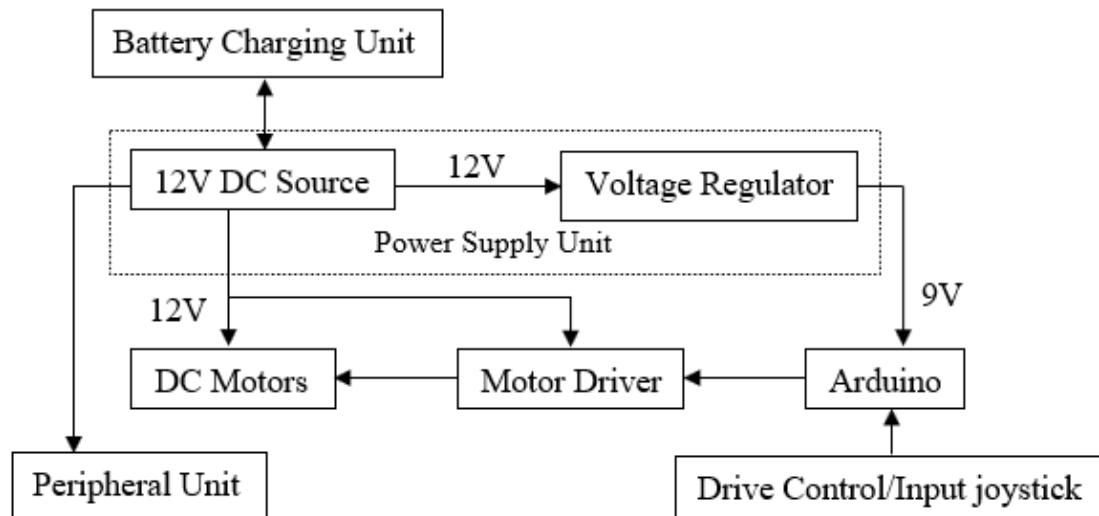


Figure 1: Block diagram of proposed EPW.

The proposed EPW is created by integrating electronic and electromechanical components, including an Arduino, charge controller, brushed DC motors and its associated circuitry, with a conventional wheelchair. The electronic portion processes joystick input into control signals while the electromechanical portion utilizes battery power to drive the wheelchair (Tulaskar et al., 2021; Stephen et al., 2015).

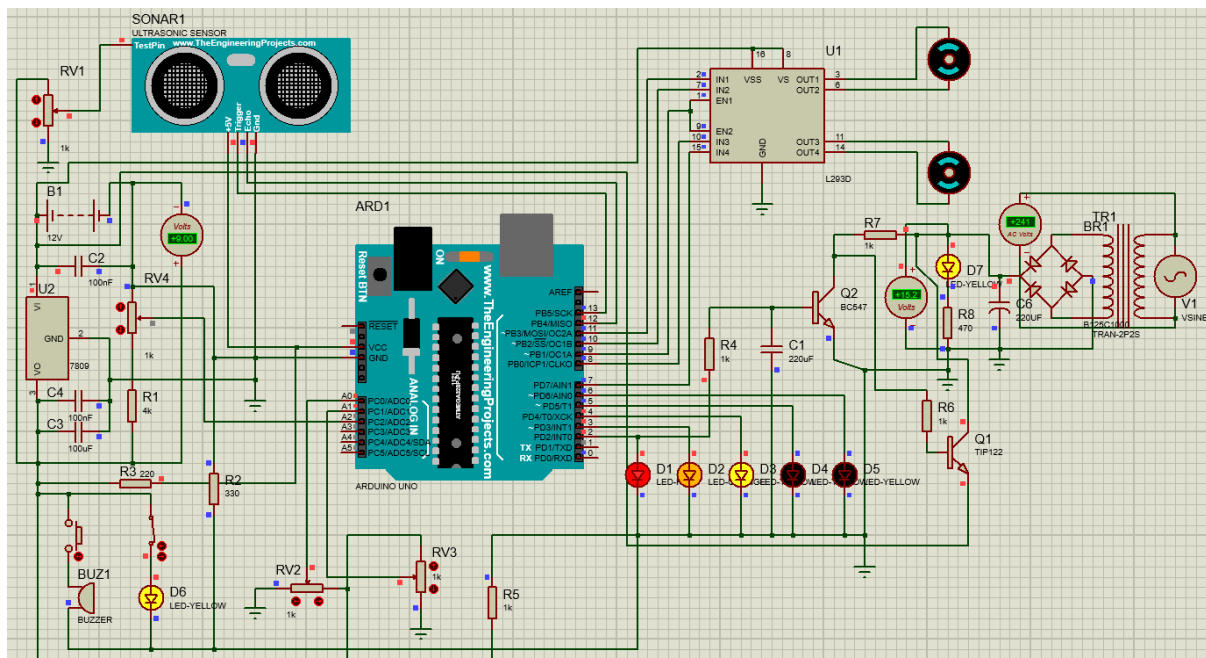


Figure 2: Schematic of proposed wheelchair, designed using Proteus EDA.

This EPW features a power supply unit consisting of a 12V deep-cycle battery and a voltage regulator. A transformer converts 240V AC mains power into 15V DC for charging the battery through a charge controller, which ensures the battery is not overcharged. The drive

control unit, incorporating a joystick, allows for speed and direction control of the wheelchair. The motor driver unit amplifies signals from the microcontroller through the use of relays, transistors, and diodes to drive the DC motors. A peripheral unit, comprising a horn and bright light, enhances visibility in low light conditions and can be activated through a switch and push button. Lastly, the battery level is indicated by a series of LED lights.

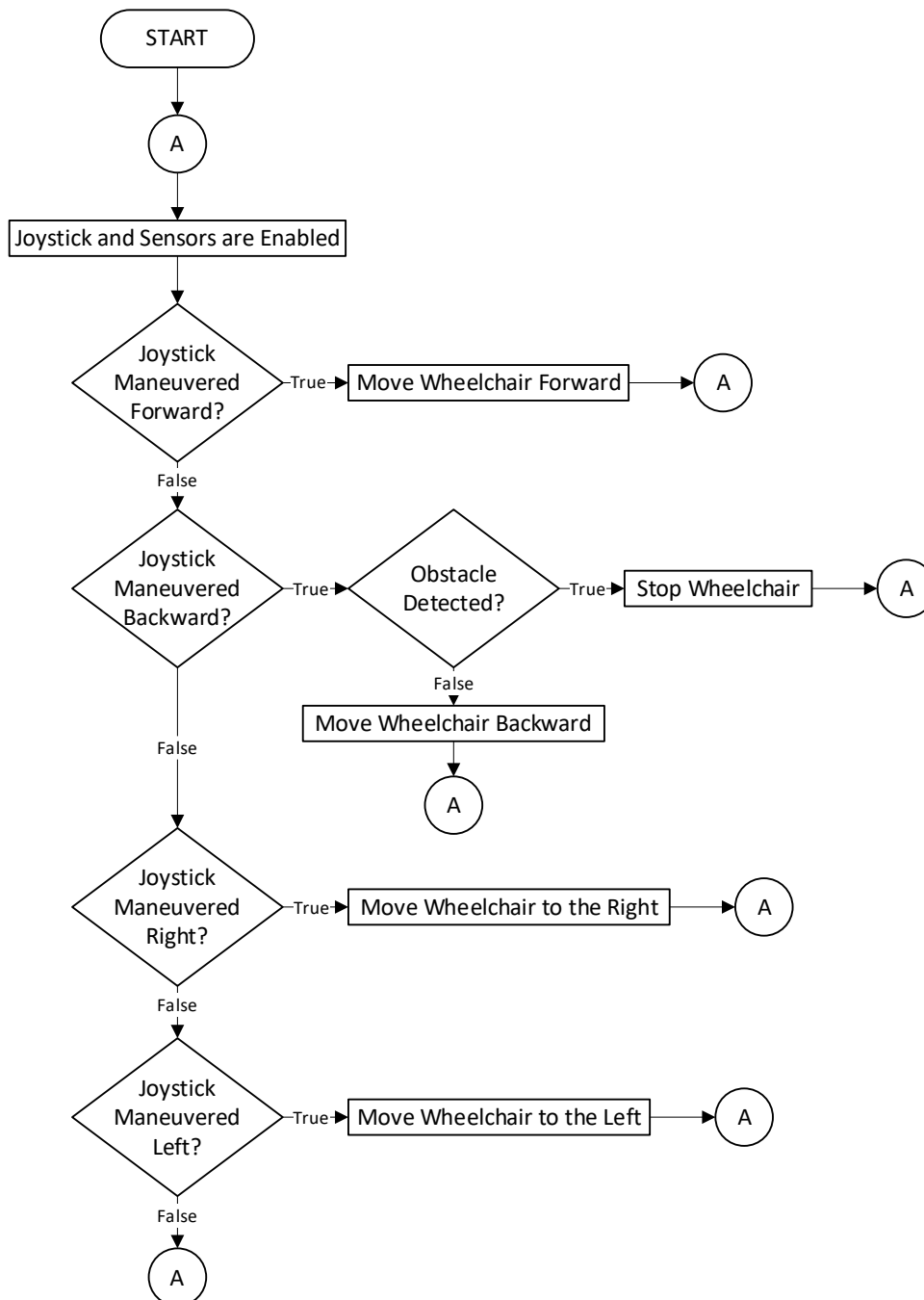


Figure 3: Control algorithm for the wheelchair.

The proposed EPW features a joystick control system, which operates by switching the motor on and off by placing the joystick in a neutral position. Gradual movement of the joystick from this position initiates the motor and adjusts the speed. The maximum speed is achieved

by fully engaging the joystick. Reversion to the neutral position reduces speed and ultimately turns off the motor. Additionally, a rear-facing ultrasonic proximity sensor halts the wheelchair's reverse movement when an obstacle is detected within 0.5m.

Results

A test was conducted to assess the effectiveness of the ultrasonic sensor in detecting obstacles behind the wheelchair and disabling movement in that direction.

Table 1: Rear Proximity Sensor Effectuality Test.

Location of Obstacle	Behind (within 0.5m)
Move Forward	Working
Move Backward	Disabled
Move Left	Working
Move Right	Working

The ultrasonic sensor demonstrated effective detection of hindrances behind the wheelchair, thereby inhibiting movement in that direction while leaving forward, left, and right movements unscathed.

Table 2: Rear Proximity Sensor Range Test.

Distance to Encounter Obstacle	Status of Backward Movement	Length at which Backward Movement is Deactivated
0.1m	Deactivated	0.1m
0.2m	Deactivated	0.2m
0.3m	Deactivated	0.3m
0.4m	Deactivated	0.4m
0.5m	Deactivated	0.5m
0.6m	Activated	0.5m
0.7m	Activated	0.5m

The experiment confirmed that the rear-facing proximity sensor effectively deactivated the backward movement of the wheelchair when an obstacle was 0.5m or closer. Beyond this range, the wheelchair continued to move backward until the distance reduced to 0.5m. These results demonstrate the intended functionality of the sensor in regards to its range.

Table 3: Instruction Execution Time Evaluation.

Instruction	Latency
Forward	0.21s
Backward	0.28s
Left	0.53s
Right	0.27s
Obstacle Detection	Undefined

The experiment found that it takes approximately 0.3225 seconds to execute user-specified instructions for motion.

Table 4: Obstacle Detection Evaluation.

Obstacles	Rear Proximity Sensor					
	Test 1	Test 2	Test 3	Test 4	Test 5	Percentage of Rate of Success
Opaque Obstacles						
Wall	✓	✓	✓	✓	✓	100%
Human	✓	✓	✓	✓	✓	100%
Baseball-bat	✗	✓	✓	✗	✗	40%
Chair	✓	✗	✓	✓	✓	80%
Translucent Obstacles						
Curtain	✓	✓	✓	✓	✓	100%
Mirror	✓	✗	✓	✗	✓	60%
Glass Door	✓	✓	✓	✗	✓	80%
Colored Objects						
Red Colored Objects	✓	✓	✓	✓	✓	100%
Blue Colored Objects	✓	✓	✓	✓	✓	100%

The experiment revealed limitations in the detection of smaller and reflective objects by the wheelchair's obstacle detection system, but confirmed its ability to accurately identify larger objects regardless of color.

The motor terminal voltage, V_{ab} , is the average voltage applied to the motor over a given period of time (Yousef & Mostafa, 2016). It can be calculated as:

$$V_{ab} = \frac{1}{T} \int_0^T V_{rated}(t) dt = \frac{T_{ON}}{T_{period}} V_{max} = \text{Duty Cycle} \times V_{max}$$

Table 5: Duty Cycle vs Terminal Voltage (6V Motor).

Duty Cycle	Computed Output Voltage (Prototype)
25%	1.5V
50%	3.0V
75%	4.5V
100%	6V

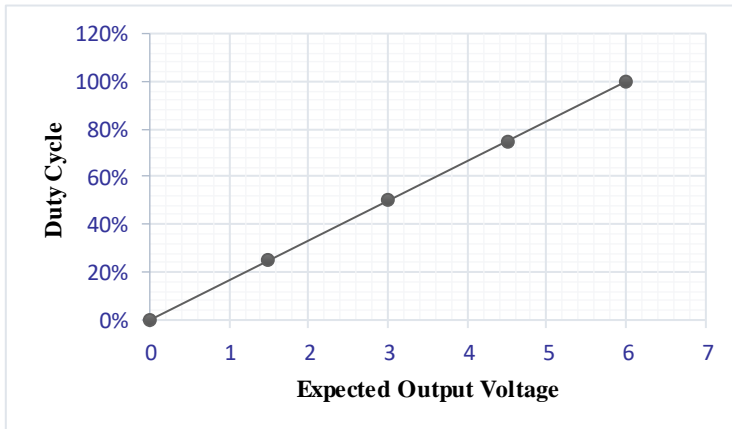


Figure 4: Duty cycle vs expected output voltage at motor terminals.

A linear correlation exists between the duty cycle of a PWM signal and the average voltage supplied to a motor. This correlation can be leveraged to regulate motor speed by adjusting the duty cycle, a crucial aspect in the utilization of PWM to control motor velocity.

Discussion

This study presents a joystick-controlled EPW that eliminates the need for attaching sensors or devices to the user. This design provides variable speed control and mobility in all directions, offering similar advantages to conventional EPWs. Utilizing locally available

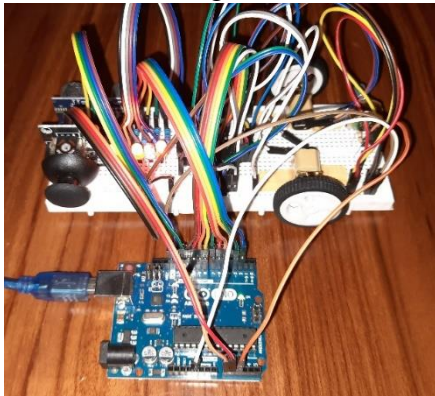


Figure 5: Prototype of joystick-controlled electric wheelchair using Arduino and breadboard.

resources, this prototype presents a non-invasive control method which offers greater flexibility in speed and direction control (Yanco, 2000). Unlike voice or vision-based control systems that may be vulnerable to external noise or limited commands (Jesse & , 2017), the joystick-based approach offers a more user-friendly and reliable solution.

This research favorably compares to other studies in the field (Ruzaji & S., 2012; Kalasamy, et al., 2014; Hongunti, et al., 2014; Kokate & Agarkar, 2014; Sudheer, et al., 2012; Nipanikar, et al., 2013; Humaira, et al., 2014).

The full-fledged EPW is designed with specified parameters, including a load capacity of 115 kilograms, maximum speed of 0.6 ms^{-1} , wheel diameter of 60 cm, maximum acceleration of 0.6 ms^{-2} , and power source of 12 volts. The force exerted on the wheel (F) was calculated as $115 \text{ kg} \times 0.6 \text{ ms}^{-2}$, resulting in a force of 69 N. Based on this, the required torque (T) was computed as $T = r \times F$, where r is the wheel radius, yielding 20.7 Nm of torque. The mechanical power, T x angular velocity (ω), was estimated to be 135 W, leading to a current

requirement of 11.5 A. The conclusion is that two motors with 0.19 horsepower each are necessary to drive the wheelchair.

Conclusion and Recommendations

This study presents a cost-efficient solution for paraplegics by incorporating locally sourced components, aligning with the objective of providing an economical electric-powered wheelchair. While the integration of two or more ultrasonic sensors and waterproof control circuitry could enhance system performance and versatility, the use of solar energy could also improve its sustainability. Although the integration of LiDAR sensors or image processing technologies could offer further benefits, they are expensive and therefore deemed beyond the scope of this project. The objective was to balance cost and performance, making EPWs more accessible to those in need. Further advancements, such as autonomous navigation and smart home functionality, may be potential avenues for enhancing the system's performance and usefulness for paraplegics.

Table 6: Cost Analysis for the Wheelchair Project.

Components Required	Quantity	Cost (LKR)
Arduino UNO	×1	3,800
0.19 HP 12V DC Motors	× 2	22,000
Ultrasonic Sensor	×1	225
12V Deep Cycle 70AH Battery	×1	58,000
Joystick	×1	240
L293D IC	×1	200
L7809CV 9V IC	×1	80
Active Piezo Buzzer	×1	200
Resistors and Capacitors	Undefined	800 (approx.)
Wires	Undefined	3,500 (approx.)
Manual Wheelchair	×1	20,000
Total		109,015 (approx.)

The cost analysis of the project (as depicted in Table 6) demonstrates its affordability and feasibility. The estimated cost for the full-fledged model is \$298 (approx.).

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AN AUTOMATED CNC FABRIC CUTTER CONNECTED THROUGH WI-FI SERIAL BRIDGE

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Abstract

Apparel industry is one of the core industries in Sri Lanka and automation can be applied in the process to increase efficiency in factories which results in higher production output. Fabric cutting stage is considered in this project, as building an Automated CNC Fabric Cutter connected through WI-FI serial bridge is proposed. It is a 4-axis belt driven machine that uses NEMA 17 stepper motors and is controlled by an Arduino mega. The G-code of the pattern designed using a CAD software, generated using Inscap software is sent to the controller with the help of the G-code sender, UGS (Universal G-code sender). All the data of the procedure is obtained in real time as the device is connected through WI-FI serial bridge. All the objectives of designing the structure and controller, building using components, testing and analyzing were accomplished at the end. Many advancements can be done in the future to improve the machine.

Keywords: CNC machine, Fabric Cutter

Introduction

Background of the study

Apparel industry is one of the fastest growing industries all over the world which improves day by day with new advancements and modifications. It can be considered as an undying field as it fulfills one of the basic needs of human beings and new techniques will be required to meet with the forthcoming growing demand. Also, considering the Sri Lankan context, garment industry tops the list out of the main productions in the country. There are over 1000 garment factories spread over the island, and garments and textiles are the key export of Sri Lanka which covers more than half of the total exports of the country. (Oxford Business Group, 2022)

Hence, it is vital for the factories to seek for methods to improve efficiency and automation will be the optimum solution. Since there are few stages in the process of apparel making and automation can be applied to each of the phases as automating the entire process may not be feasible in some cases when considering few unavoidable factors (Kiron, 2021). Fabric cutting is one of the stages and the proposed system here is to automate the cutting process.

Out of the total expenses of fabric production, cost of fabrics and cost for cutting and sewing takes up around 50 to 70 percent in garment manufacturing. Most of the conventional factories use manual ways to carry out the cutting operation. It is done with the help of laborers where they perform it generally with manual blades. This consumes a lot of time as everything needs to be done physically which results in less efficient and accurate products. Likewise, it occupies lots of workforce and thus the cost of labor is also high. With the invention of numerically controlled technologies in 1940s and 1950s, cutting processes of factories started witnessing an era of improved operations with the help of diverse types of

cutting (Suh, 2020). Since, time consumption and cost of production are primary factors that effect on the efficiency of production, it is important to lessen these factors when concerning about the long run of the businesses and automation will be the greatest solution.

The aim of this project is to implement an Automated CNC Fabric Cutter with higher efficiencies and higher accuracies to be used in the garment industry because there is no such a machinery available for small scale garment industries.

Methodology

The most appropriate design was selected out of few suitable design options obtained after conducting a thorough literature survey and the functioning process of it is explained in the following flow chart.

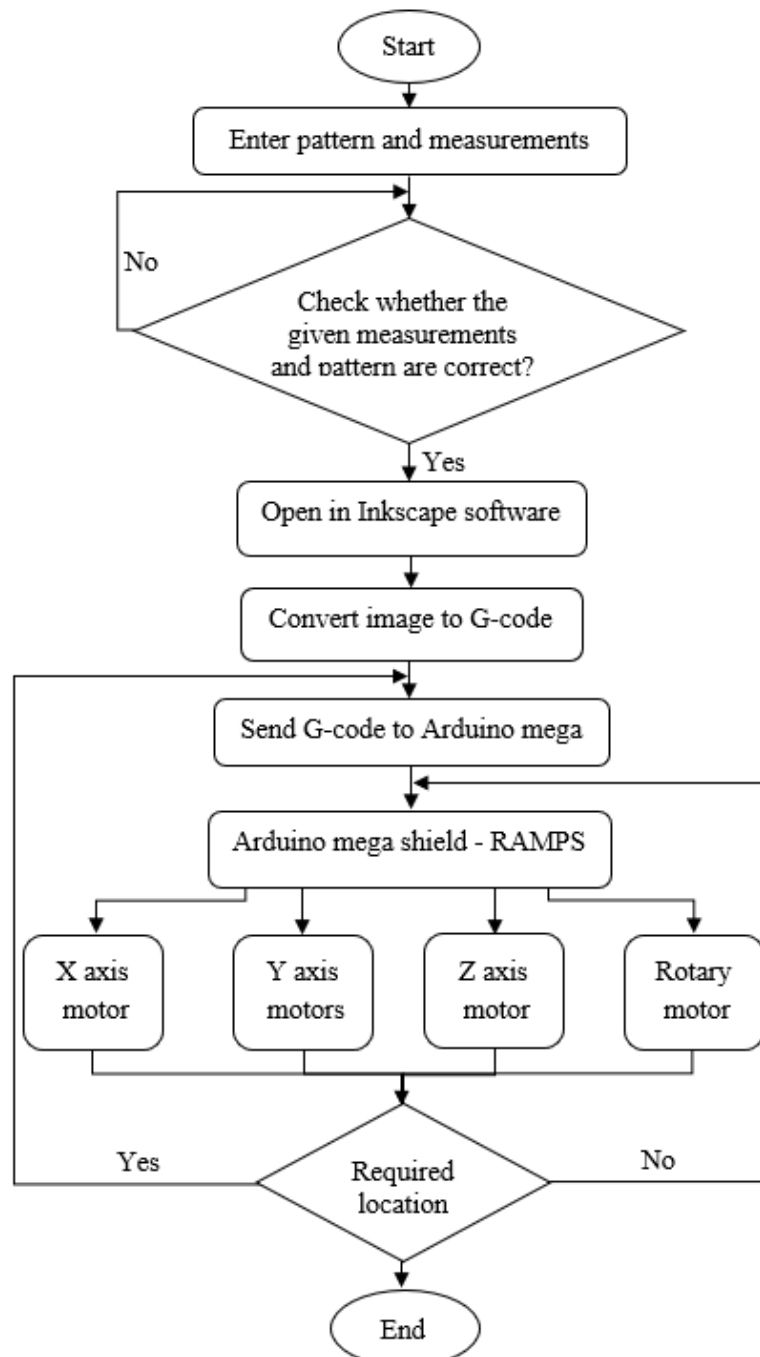


Figure 1 - Functional Flow chart

Design & Implementation

As the first step in the designing process, electrical circuit was developed and is displayed by Figure 2. It consists of five motors with drivers, one for side movements in the X axis, two for movement along the two sides of Y axis, one for up and down motion along Z axis and one for the movement of the rotary axis. Four limit switches are used as one per each axis to control the motion. The NodeMCU ESP8266 module is used to connect to the Wi-Fi which helps in interacting with the internet (Components101, 2020). The electrical circuit is mainly controlled by an Arduino Mega board (DeMeyer, 2017) and all these

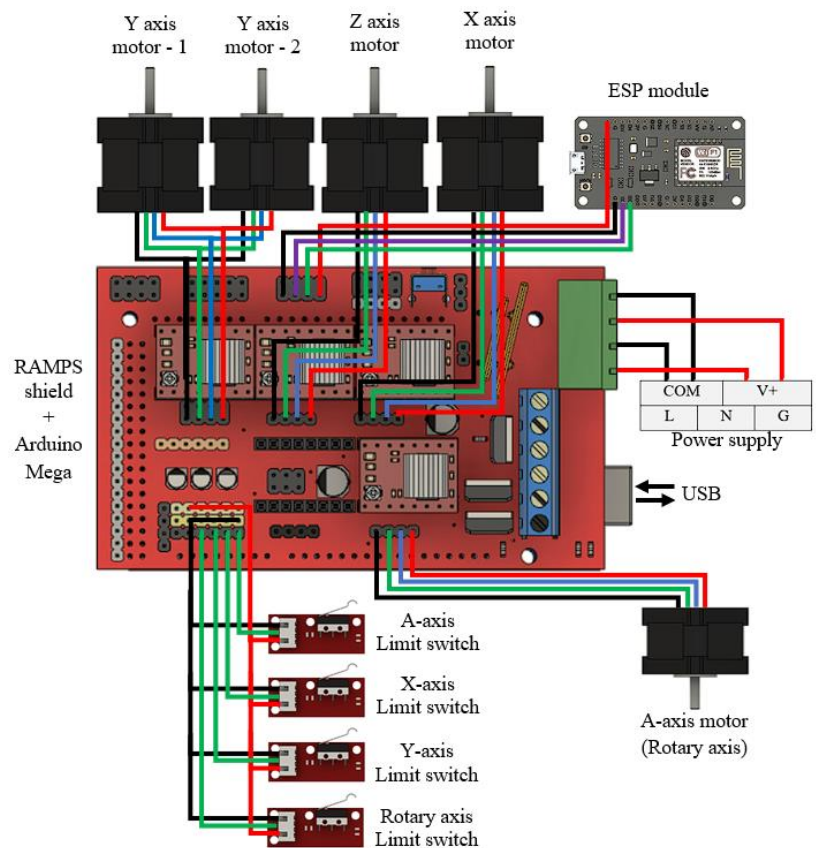


Figure 2 - Electrical Circuit

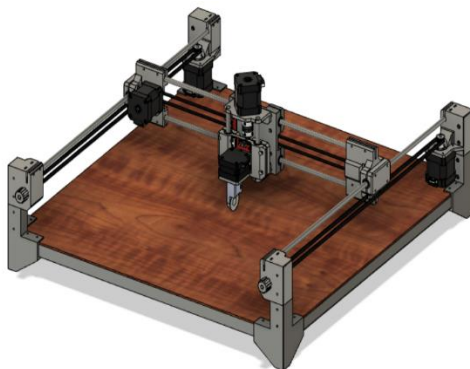


Figure 3 - Designed 3D Model

components are connected to it through an Arduino Mega Shield RAMPS (Domoticx Knowledge Center, n.d.).

The 3D model of the mechanical design was created using Autodesk Fusion 360 software and complete 3D model was shown in figure 3.

Prototype implementation

As per the above 3D model, the machine was built using real components to demonstrate the proposed design. When building, certain blocks were required for assembling the components and for the fixed structure of the machine. They were all printed using a 3D printer as shown in figure IV. The type of material used for this is the PETG filament. The electrical components, things needed for the frame like shafts (GlobalSpec Engineering 360, n.d.), bars and the printed parts are linked together by using 3M nuts and bolts. Bearings were used for the blocks to move along the shafts smoothly. A rotating wheel called a

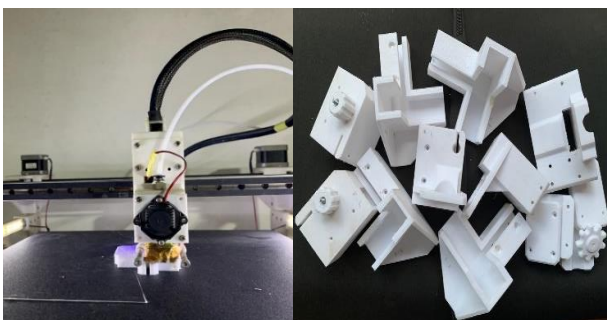


Figure 4 - Printing parts using a 3D printer

pizza cutter blade is used as the cutting tool in this machine.

The basic frame structure of the machine which helps in the movements along the X and Y axes is shown below. The Z and Rotary axes were assembled separately and then connected to the X carriage (Figure 6).



Figure 5 - Basic Frame Structure



Figure 6 - Z and Rotary Axis Assembly

Software, Firmware and EPS WI-FI serial bridge configuration

Marlin was an Arduino based open-source firmware that mainly used for 3D printers. The Marlin firmware was available on GitHub under the open-source license for developers and hobbyists. Mainly this firmware was build for 3-axis and two extruder configuration but doing some minor changes the one of the extruder output can be change to an additional axis (rotary axis). These changes were done via Arduino IDE. The marlin firmware was designed to use cartesian coordinates and with the additional axis it was able to work with any G-code sending software.

The WI-FI serial bridge was configured using the ESP-link firmware. ESP-link was an open-source firmware that available in GitHub. To configure ESP-link it needed an additional ESP module that have built-in WI-FI. In this case an ESP8266 module was used. Once the ESP-link configured to module and connected to desired WI-FI network it automatically creates a serial bride between Arduino MEGA and user computer (via port 23). Additionally, this also allow user to monitor and control the system via any

Inkscape software is used to draw the required pattern and the G-code can also be generated from the same software. The G-code is then sent to the machine via serial bridge.

Results and Discussion

The software simulation on the machine was done by G-code generator by checking whether correct G-code paths were created. The results obtained after completing the entire implementation and feeding the required cutting pattern are displayed by the following pictures. However, there were some minor accuracy inconsistencies due to linear axis vibrations and miss alignments. But overall results were much similar to the given design measurements with $\pm 0.5\text{mm}$ errors and that is neglectable. The system velocities, accelerations and rotational accuracies were adjusted by performing some commonly used patterns (circles, rectangles, triangles, etc.) again and again until gets the best accuracy values. Then these values were updated to the firmware for final product.

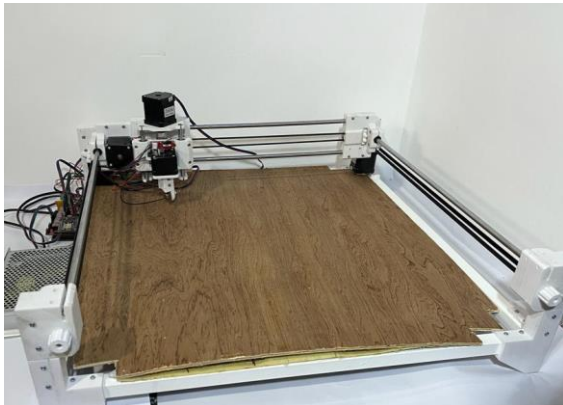


Figure 7 - Cutting tool at the 'Home' position:

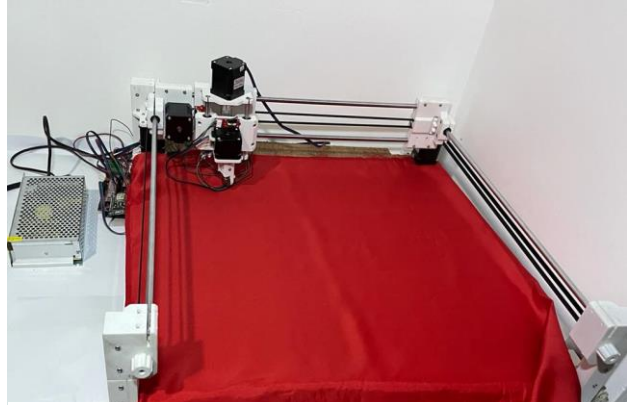


Figure 8 - Fabric material laid on the bed for cutting:

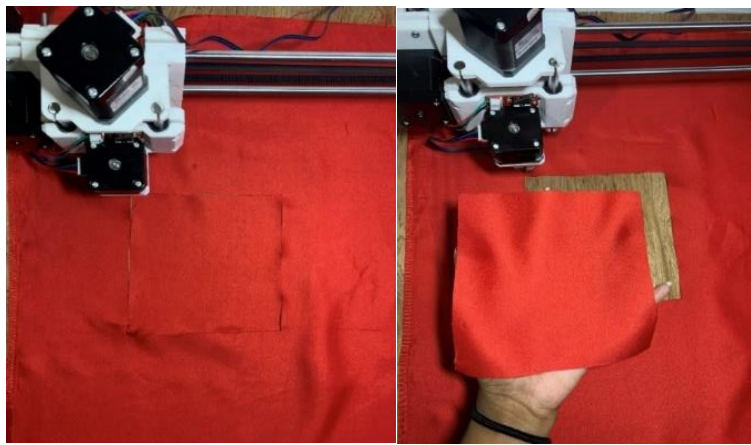


Figure 9 - Before and after the pattern was cut out using the machine

As it was required at the beginning of the project, the machine was built by satisfactorily achieving the overall objective of cutting fabrics. When commenting on the test results of the machine, there were some slight disparities in the final outcome. Movements along the X and Y axes were not smooth and had some lagging in the motion. This was overcome by adding some oil to the bearings of the two axes and fixing the belts a bit. Another problem in the results was the minor error in accuracy of the cutter movement.

Few challenges were faced during the completion of the project. There were some errors in the printed parts and therefore some had to be reprinted and some parts had to be modified a bit. Moreover, with the existing situation of the country, the components were pricey way more than the usual rates and it was difficult to find few components in the market. Also, due to daily power cuts it was fairly challenging to complete the project especially when printing 3D parts and building process of the machinery.

Conclusions and Recommendations

Cutting fabrics manually in garments takes a longer time, increases cost of labor and workforce and using conventional methods affects the continuity of the process during system breakdowns. So, the aim of this project was to implement an Automated CNC Fabric Cutter to be used in the garment industry and it was achieved at the end. If the machine is to be

better improved and advanced, the following can be stated as the recommendations given for changes.

- Springs can be added to the Z axis for a smoother up and down movement of the cutter and to control the pressure exerted on the fabric and the bed of the machine.
- A healing mat to be mounted on the bed of the cutter machine to avoid damaging the bed when the cutter is pressurized onto the surface.
- The cutting tool used here is a rotating wheel cutter which can only cut a single ply of fabric at a time. As a step to improve the efficiency of the machine, instead of the wheel blade, a laser cutter can be used as the cutting tool. This would result in a more precise and clean cutting of the material and can cut out number of layers in a single operation.
- Can be advanced to a multi-tool machine by adding more tools to the rotary axis.
- Advancing it to a fully automated system from spreading the material on the surface to cutting out the desired shape.
- Using WI-FI serial bridge can be further enhanced and develop a mobile application for monitoring the process.

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PROVIDING ADDITIONAL POWER TO CHARGE THE BATTERY IN VEHICLES BY UTILIZING POWER GENERATED SHOCK ABSORBER

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Abstract

The function of a regenerative shock absorber is to recover vibration energy that would otherwise be dissipated as waste in the form of heat. In this project, it was expected to re-use that shock absorber's dissipated energy and transfer it to the extra power needed to run automobiles by electromagnetic induction. This report was begun by discussing existing researches and the significance of regenerative shock absorbers. Then, build a product model that shows how the power generating shock absorber works, how the generated electricity is used to recharge the battery, and how the voltage and amperage are displayed. The planned prototype was far less expensive and smaller. The VA generated system's voltage is directly proportional to the up and down moment of the shock absorber. If the voltage is higher than the battery capacity, it has the possibility of battery charging.

Key Words: Liquid Cristal Display, Magnetic Field, Shock Absorber, Voltage and Amperage

Introduction

With reference to the past studies, Fossil fuel were rapidly depleted. Fuel prices were increase gradually in the past recent years. As a result, someone must work to reduce the fuel consumption. In this report, it was able to demonstrate how the kinetic energy from a car's suspension can be used to maximize the energy that would otherwise be wasted.

A shock absorber absorbs and dissipates kinetic energy by dampening or smoothing out shock impulses. The function of a shock absorber is to absorb or dissipate energy. It was used to reduce the effect of driving over uneven ground, resulting in better ride quality and increased comfort due to significantly reduced disturbance amplitude. When considering the movement of a vehicle on a level road and if the wheels come into contact with a bump, the compressed spring will try to return to its normal loaded length, rebounding beyond its normal height and lifting the body. The weight of the vehicle will then lower the spring below its normal loaded height. As a result, the spring will need to re-bound. This bouncing process is repeated, a little less each time, until the up-and-down movement comes to a halt.

Background

According to the “Electromagnetic shock absorber” by (Aravind Ajith et al., 2014) repulsive forces from the same poles of permanent magnets/electro magnets were used to absorb severe shock loads in the magnetic shock absorber. The magnetic shock absorber has two permanent magnets in the top and bottom end covers. A second magnet was attached to the movable rod. According to their article, the magnet will travel up and down vertically with the rod, and all magnets will be set such that their poles face each other, assisting in the creation of a repulsive force for shock absorption. The top end cover is bolted to the vehicle's body, and the moveable rod is bolted to the vehicle's axle at the other end.

It was Shown a unique high-efficiency energy regeneration shock absorber, that used super capacitors to enhance the battery endurance of an electric vehicle in “Journal of advanced in engineering and technology Design and Analysis of Regenerative System in Shock Absorber” by (Mahaboob Basha, Akhil Kumar and Balasubramanyam, 2018)” For range-extended EVs, a renewable energy application system utilizing regenerative shock absorbers was developed.

As depicted in “Power Generation using Vehicle Suspension” by (Moon et al., 2018)It was devised a design strategy that transforms mechanical energy in automobiles to electrical energy significantly more efficiently than previously.

“Simulation on Eddy current damper and its regenerative behavior in shock absorber for electric vehicle” by (Mechatronics, Tunku and Rahman, 2013) Was briefly discussed the reasons behind the rise of electric vehicles, as well as some of the existing energy regenerating suspension systems, before proposing a novel hybrid damper.

Also, the history of electric vehicles was briefly discussed in that report. Finally, the concept, design, and concept of the new hybrid damper are briefly explained.Shock absorbers, according to “Design and analysis of a shock absorber” by (Martande, Jangale and Motgi, 2013) and by (Pinjarla, 2018) it was an important aspect of a car's suspension system since they connect the vehicle to its wheels. The roll and pitches associated with vehicle handling, as well as the roughness of roadways, need the usage of dampers.

The design and finite element analysis of an electromagnetic energy regeneration shock absorber, which can efficiently recover vibration energy wasted in car suspension systems, were reported according to “Design and static magnetic analysis of electromagnetic regenerative shock” by (Uttamro Patil and Gawade, 2012) Three various ways for recovering this waste energy were investigated and compared in order to determine the optimum option.

Objectives

To Choose a suitable electricity-generating system to convert kinetic energy to electric energy, apply it for shock absorbers and design a power-generating shock absorber, create a product model that demonstrates how the power generating shock absorber works and, apply that generated electricity to recharge the battery in the model, Design two systems, one to display the output Amperage with voltage and other to recharge the battery and to assess the power output and the characters.

Significance Of The Work

This method of conversion and utilization of energy can be used to charge the batteries in electric, hybrid, and conventional automobiles. Because of the bumps and frequent oscillations, it is mostly beneficial and suitable for off-road vehicles. It is also useful for the lighting system at night, as well as for the winch as an alternate current source.

Methodology

1. Design of the product model

Selecting the most appropriate power generating method.

Needed requirements,

- The system was designed to transfer kinetic energy into electricity rather than heat using a linear motion.
- When going over bumps, the shock absorber moves up and down in a linear motion, thus to match that motion, A shock absorber was chosen which moves up and down in a linear manner.

To select the most suitable method which fulfills the above requirements, it was decided to use the electromagnetic induction method which generate power through the shock absorber.

A drilling machine was used to wind 5000 turns in a handmade cardboard bob.

Factors effecting when designing the coil

- Number of turns – if we increase the number of turns, we can get more induced current
- Material of the core – here we use the cardboard core it has the lowest permeability
- Shape and size of the core – the core should made close to the permanent magnet to get better magnetic flux
- Arrangement of the wire making up coils – here we use gauge 38 very thin wire
- Speed, strength of the magnet – when increasing the speed, the electro motive force also increasing
- Wire thickness- thicker wires have less resistance, allowing more current to flow.

Coil winding

Firstly winding – when winding 1000 turns in the coil we get like 0.8 volts from the coil when magnet is moves through the coil

Second winding – from 2500 turns we get like 3 volts

Third winding – from 5000 turns we get like 5v to 6v



Figure 1: Coil Winding using drilling machine Figure 2: Coil winding on a handmade cardboard

Acrylic Sheet Clear Plexi plastic board cutting.

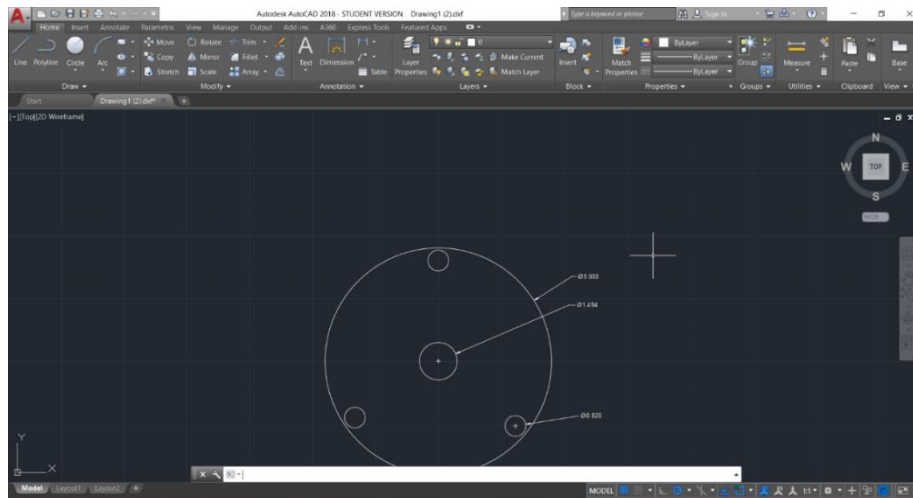


Figure 3: Drawing for cutting design of Acrylic Sheet Clear Plexi plastic board by using Solid works software 2017 version

Used laser cutting to cut the Acrylic Sheet Clear Plexi plastic board



Figure 4: laser cutting of Acrylic Sheet Clear Plexi plastic board



Figure 5: Assemble chassis



Figure 6: Final shock absorber product model

A model was constructed to demonstrate how to create power with a real shock absorber, using Faraday's electromagnetic induction law premise. The shock absorber was made up of two tube-like components, with copper coils twisted around a cardboard bobbin and ring-shaped magnets separated by magnetically permeable ring-shaped spacers. The chassis was strengthened by three metal rods attached to circular Acrylic Sheet Clear Plexi plastic boards, and the center of the movable rod was equipped with a permanent magnet. The current was generated via electromagnetic induction due to the change in magnetic field in the coil.

2. Design the system for Voltage and Amperage displaying.

Firstly, Arduino Nano was programmed by a programming code.

Supplied 12 V power

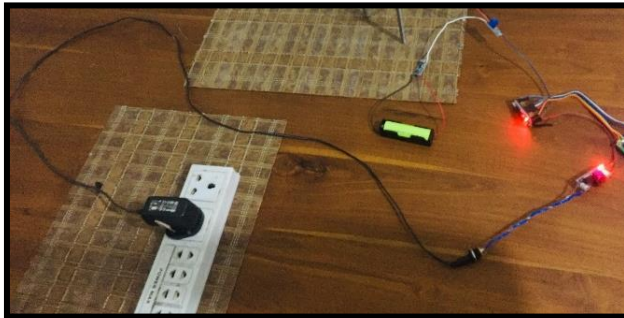


Figure 7: Supply 12 V power

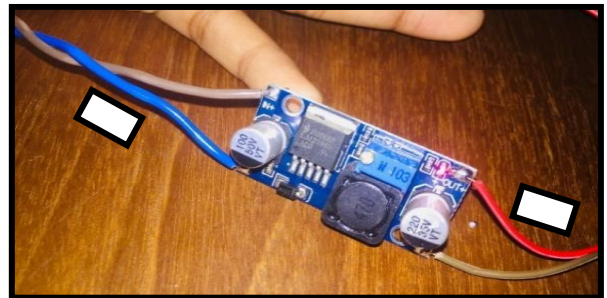


Figure 8: Make 12 V power to 5 V by using step down converter to power up the Arduino nano

All the pins were connected using jump wires as shown in below diagram

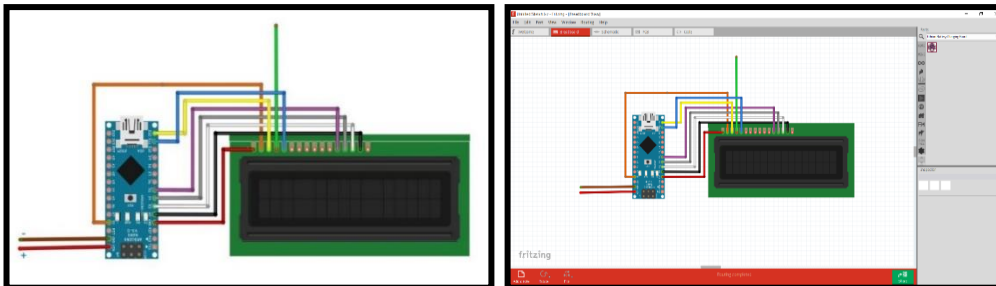


Diagram 1: Pin diagram that draw using Fritzing software

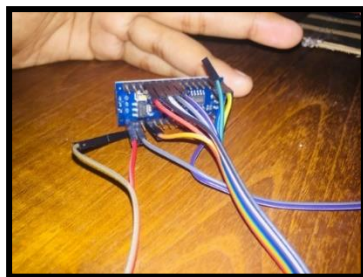


Figure 9: Data pass to the display through 0 pin of Arduino nano

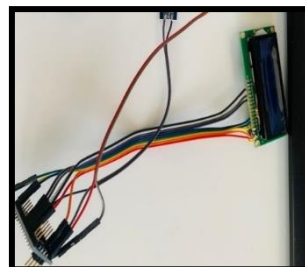


Figure 10: Soldering an extra ground pin



Figure 11: Adjust the display lighting and brightness

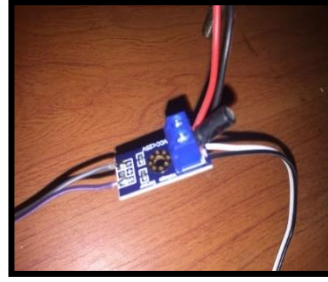


Figure 12: Capacitor placed where the input of the voltage

3. Designed the system to charge the rechargeable battery.

The current that flows to the voltage sensor from the shock absorber model was passed to the battery through battery charging unit by connecting and soldering.

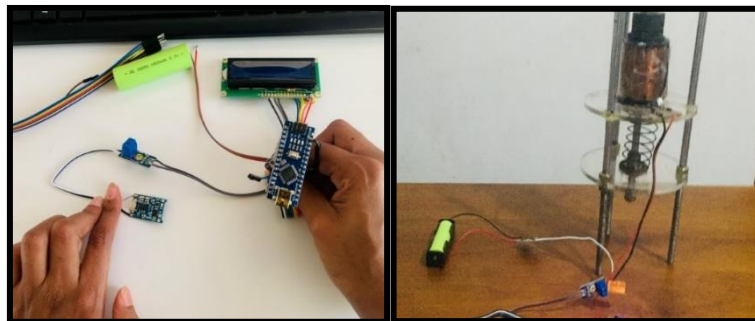


Figure 13: The current that flows to the voltage sensor from the shock absorber model, pass to the battery through battery charging unit by fixing and soldering

Assembled the prototype design with two systems that display voltage and amperage and battery recharging system.

Flow Diagram of the Prototype Design

An overview of the entire process followed when designing the circuit board is shown in the following diagram.

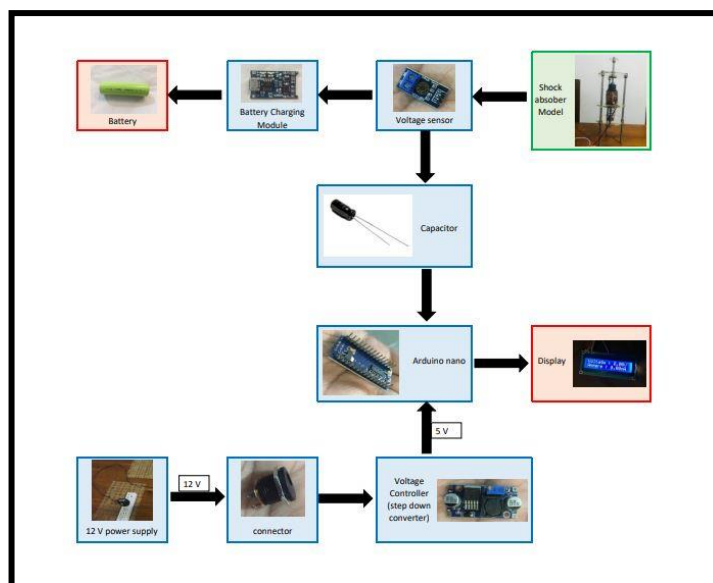


Diagram 2: An overview of entire system

Test, Results and Analysis

Chosen components and characteristics

Step down converter

To reduce the voltage efficiently, in this project it was used to reduce 12 V supply in to 5 V for power up the Arduino nano.

10 μ F 16V Capacitor

To prevent the current drop when manually pressing and releasing the shock absorber model, a 10 μ F 16V capacitor was used.

Rechargeable battery and Micro interface lithium battery charging board

In this project 3.7V rechargeable battery was selected. (According to assembled Shock absorber model, it generated around 5 – 6 V.) charging board will safeguard battery packs from overcharging, over-discharging.

Arduino Compatible nano and LCD 16x02 Display

Arduino boards can read inputs and convert them to meaningful outputs without spending much effort. And the data was sent to the display through this Arduino nano.

Voltage Detection sensor

Voltage supply can be determined, analyzed, and measured with the use of a voltage sensor. It has the ability to measure both AC and DC voltage levels.

Rectifier, Condenser and Regulator

Converting the power supply from AC to DC is made easier by using a rectifier. During power outages and changes in load, it controls voltage. So, DC voltage can be regulated by the regulator.

Calculations of the product model

In here, since the product model was manually operated, it was not displayed how much net energy can be save after 30 minutes' drive.

As per the calculation given below Electromotive force generated by coil per 1 second: 2.5v

So, for 30 minutes it can generate: $(2.5 \times 3600)/2 = \underline{4500v}$



Figure 14: Final model and entire system

Calculations of the product model

- Number of turns in the coil = 5000
- Length of the coil = 6 cm
- Area of the radius cross section of the coil = 1.75 cm
- Current generated from the coil = 0.5 A
- Permeability of the paper = $1.26 \times 10^{-6} \text{ kgms}^{-2}$
- Voltage generated by the coil = 4 V
- Resistance of the coil = 890 Ω

Magnetic field strength of the magnet use,

By using, $B = \frac{\mu NI}{L}$

$$B = \frac{1.26 \times 10^{-5} \text{ Hm}^{-1} \times 5000 \times 0.5 \text{ A}}{6 \times 10^{-2}}$$

$$B = 0.521 \text{ T}$$

Electromotive force generated by the coil, (Per second)

By using, $\varepsilon = N \frac{B \cdot A}{\Delta T}$

$$\varepsilon = 5000 \times 0.521 \text{ T} \times \pi \times 1.75 \times 1.75 \times 10^{-4} \text{ m}^2$$

$$\varepsilon = 2.5 \text{ V}$$

**The permanent magnet's magnetic field strength is quite modest, but if a high-power magnet is used, a significant voltage can be obtained.*

** When moving the magnet at different speeds, the coil generates voltage between 4 and 5 volts.*



Figure15: Different voltages and amperages displayed when pressing the shock absorber model in different speeds

Before and after stages of battery voltage's results

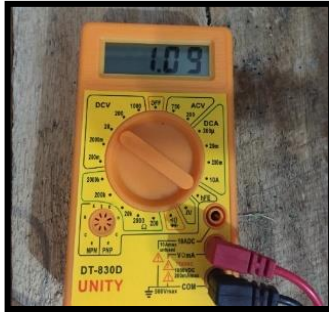
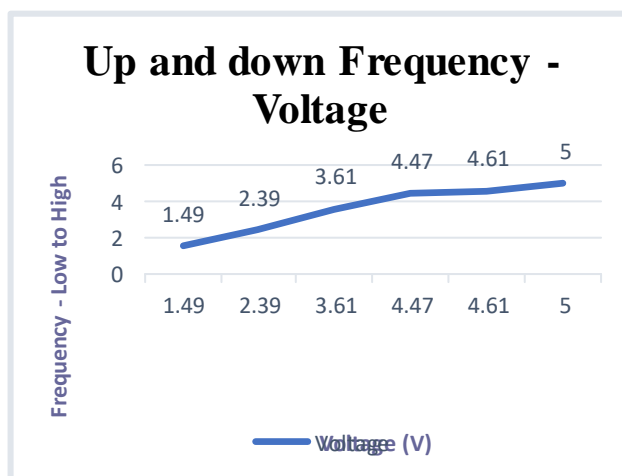


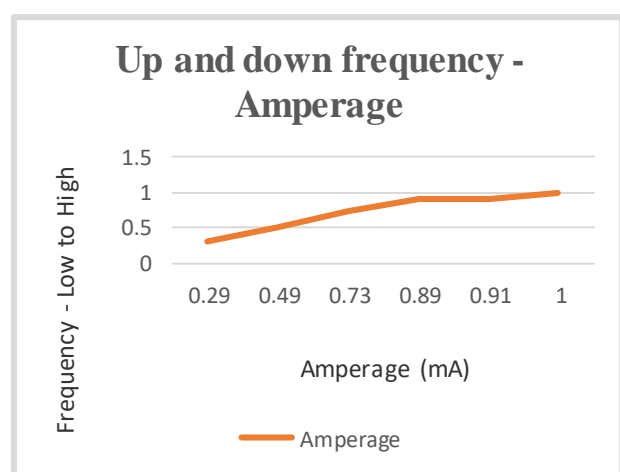
Figure 16: Battery voltage Before the battery charge by shock absorber model



Figure 17: Battery voltage after the battery charge by shock absorber model



Graph 1: Up and down frequency – Voltage



Graph 2: Up and down frequency - Amperage

The SA model generated low voltage when the shock movement was performed manually, and high voltage when the magnet-fitted rod was moved manually at a faster rate.

Amperage is proportional to the frequency of the shock absorbers up and down moment, and is generated when the magnet fitted rod is pressed and released at a higher rate than before.

Discussion

This shock absorber can be assembled without modification or in the traditional manner and Suitable for all four-wheeled vehicles. Can effectively recover vibration energy lost in a vehicle suspension system. Can be used to charge batteries of electric and hybrid vehicles which are moving on uneven grounds with bumps and shakings.

A prototype model was unable to produce a high voltage due to the lack of a powerful enough magnet. An external ground pin was soldered to the Arduino board as one ground pin lacked in the original board.

Conclusions

The approaches used in the system provide a simple and effective method of generating electricity to recharge a battery, as well this method can be introduced as a method of implementing a low-cost power generating shock absorber which display the voltage and Amperage with different variations in power generation. The power generating shock absorber raises the possibility and awareness of waste energy being recycled in a practical, realistic manner. When testing the shock absorber, it was noted that it can generate power and if this regeneration device is mounted on all the wheels in a vehicle, a large amount of electricity can be generated. Also, when testing the VA generated system, it was found out that the VA is directly proportional to the up and down movement of the shock absorber.

Recommendations

It was to develop a prototype power-generating shock absorber. In the future, the system could be improved and developed to improve its performance and functionality, and to transit it from a prototype to a fully functional product. Perform correct calculations before constructing a shock absorber, then construct a power-generating shock absorber based on the results, using appropriate materials, and test the shock absorber in a real vehicle. The regenerative shock absorber's viability has improved due to the quick growth of new technology. To be installed on the vehicle, a regenerative shock absorber must meet the power output, energy harvesting efficiency, and vehicle dynamic control requirements.

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DEVELOPMENT OF A 5-DOF ROBOT MANIPULATOR ARM FOR SMALL-SCALE MATERIAL HANDLING PURPOSES

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Abstract

Prototyping is the process of experimentation and the creations of design to tangible, physical form that were on paper or in someone's mind. To archive that easily, machines with high levels of movements and accuracy like robot arms were used. The aim of this project was to design and build small scale 5-dof (5-degrees of freedom) robot manipulator for material handling purposes and bring new innovations even further. By identifying the specifications for the robot manipulator for its purpose, a robot manipulator design and a controller to control its motion for the manipulator were designed. Afterwards it was developed as a real-world prototype by integrating functional components and test it in operation. Either a cartesian manipulator system with added rotary axis or robot arm was typically used for this purpose. This design was based on Poler system that typically used in 3D printer designs. By adding two more axis to three degree of freedom Poler system it increases the flexibility of the system. Poler system is a compact design comparing to other designs that available. A computer aided model was designed to check the idea and functionality and later used to manufacture the robot manipulator. A physically implemented system was used to test the coordinating system and the system limitation and the outcome was mostly similar to the expectation of the system. Some physical limitations were different than the theoretical limitation due to component and material differences. This design can be improved using more advance components and use it for 3D printing, milling, plotting for the development of small-scale manufacturing and rapid prototyping.

Keywords: prototyping, 5-dof, manipulator

Introduction

Background of the study

Prototyping is the process of experimentation and creation where the designs that are on paper to a tangible, physical form. This allows the testing of the functions of the designs as well as troubleshooting and problem fixing. Prototyping is a critical step in many industries that involves any kind of designing to make a real-world product. The importance of prototyping is on such a scale that many industries have entire units dedicated for the sole purpose of building prototypes from designs (Christoph H. Loch, 2008).

With the advancements in the technological sector and different tools becoming more accessible to more people, new innovative ideas and designs are thought of every day. However, a major drawback is that not all of these people have access or the finances to bring their ideas and designs to the crucial prototyping stage. As the complexity of their designs rises, the need for a prototype also increases as the problems need to be found before investing in building their design. 3D printers and other CNC (Computer numeric control) machines are now more commonly used than ever, however, not all available 3d printers,

milling machines, can provide the required accuracy that might be needed to create a prototype of the design. (Chua & Leong, 2014). The lack of affordable and easily accessible machines can hinder the designs and advancements that come forth. Specifically in use cases where the flexibility offered by the 5 DOF is a requirement.

By introducing an affordable desktop robot manipulator, an area that is lacking in the technology sector can be filled. Robot manipulators with 5 degrees of freedom allow for very high levels of movement and accuracy. The manufacturing cost of this design should be kept as low as possible. This can be achieved by sourcing the components through cheaper but reliable manufacturers, limiting the working space and using open-source software for the robot. The introduction of a cheap and powerful 5 DOF robotic manipulator can drive innovation even further by aiding the design process as a prototyping tool.

Methodology

An appropriate design was selected out of some conceptual designs that obtained after conducting a literature survey and a weighted object analyses from selected conceptual designs. The process designing and manufacturing of the robot manipulator is shown in the below diagram.

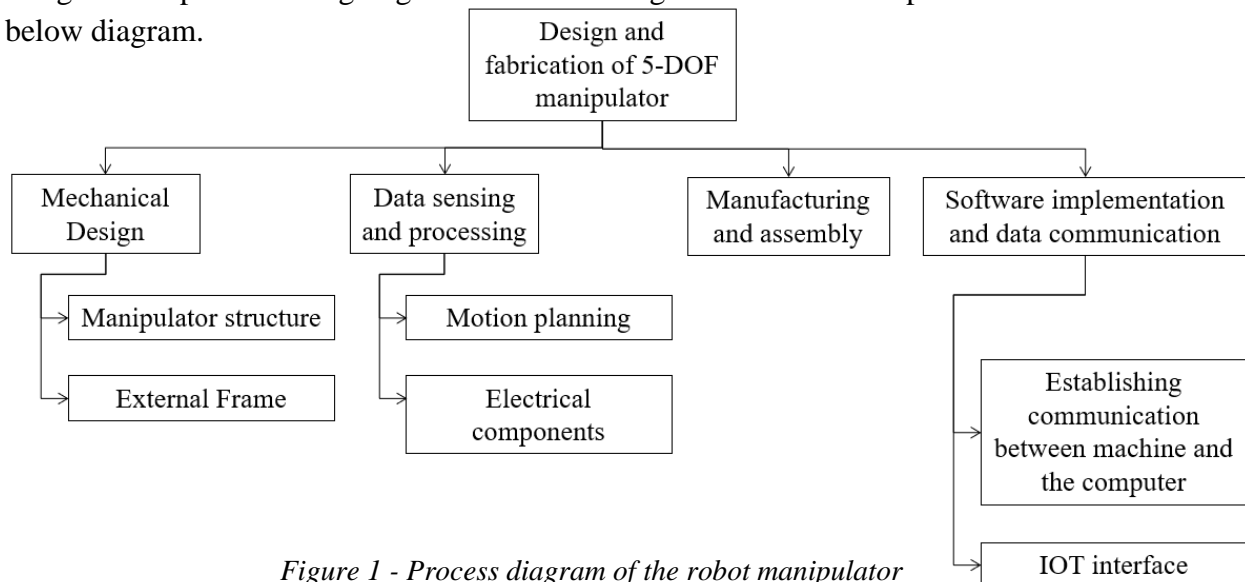


Figure 1 - Process diagram of the robot manipulator

Material and component selection

Most of the parts of the machine are done by 3D printing and filaments made of plastic materials are used for this purpose. Considering the requirements such as yield strength, density, price and printability, PETG (Polyethylene terephthalate glycol) was used as the material for the printing of machine parts. Based on available printing materials, PETG shows higher Yield strength, and an excellent price to performance ratio. The relatively higher density of the material can be offset by using lower infill values for the internals of the printed components. This will create components that are not fully solid and will lower the density of the printed parts resulting in lighter parts. An Arduino MEGA 2560 was used as the central processing unit and it handles all inputs and outputs and a RAMPS (RepRap Mega Pololu Shield) 1.4 shield that primarily used in 3D printers was used as a power distribution board for Arduino and drivers. The machine joints and gear drives are powered via Nema 17 stepper motors and these motors are driven with A4988 stepper drivers. An ESP module was

use for the wireless communications. The whole system run via 12V DC power source. Mechanical components are selected according to the CAD (Computer aided design) design.

Electrical component assembly and wiring

The whole system has a 12 V system that runs the RAMPS shield with the Arduino MEGA, stepper motors, stepper drivers and sensors. From the 230 V main power input, 12 V switching power supply is used to supply the power to the RAMPS board, which is then distributed to the Arduino MEGA, stepper drivers and sensors. Then separate wires are run from the stepper drivers to each stepper motor. The entire system is switched from the wall outlet with an emergency stop switch to cut the whole system power in case of malfunction in the machine. The 12 V power supply and the system frame is connected to the wall outlet ground in case of current leak

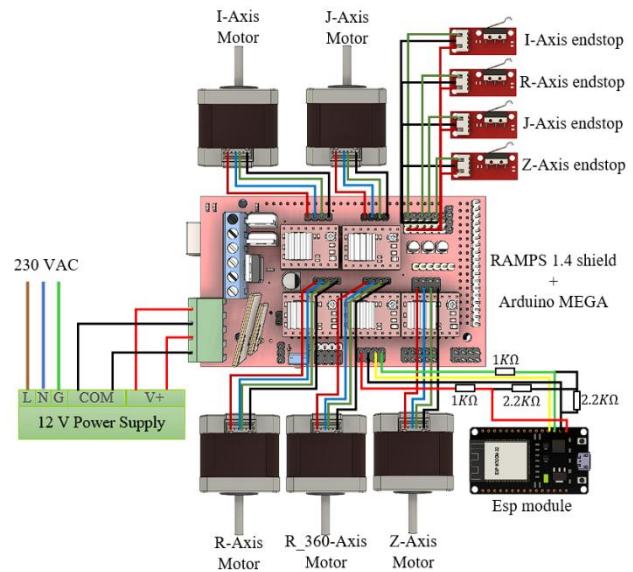


Figure 2 - Robot manipulator wiring diagram

in the system. The Arduino MEGA board, RAMPS 1.4 and stepper driver had to stack top of each other in correct orientation then connect the wires according to wiring diagram as shown below. In this case stepper driver micro stepping was set to 1/16. Stepper motor connectors have to connect by checking the stepper motor spinning direction. If the stepper motor spins wrong direction, stepper motor connector has to disconnect and flip the connector and reconnect while system is power off. At last, the ESP module had to connect to the Aux-1 output of the RAMPS board. The RX and TX pins of ESP had to connect to the RAMPS board Aux-1 pin set's TX and RX pins are shown in the wiring diagram. The ESP modules are only supporting 3.3 V. Therefore, a resistor voltage divider bridge had to use in this wiring. Resistor voltage divider bridge uses two resistors as shown in the wiring diagram.

Gear drive design

Cycloidal drive is the mechanism that used as a speed reducer and its able to reduce speed for high ratios in small space. The cycloidal drive does this using the rotor disks that has its own unique motion. When designing the cycloidal disks, some of features are using parametric features on the equation driven curve tools. The rotor disk part is very important part because of its unique shape. This unique shape is something that wouldn't be easily constructed using the basic CAD sketch tools. To design this shape an equation driven curve tool is used with following equations (Eq-1 and Eq-2) and Fusion 360 software was used for CAD designing.

$$X = (R * \cos(t)) - (R_r * \cos((t + \arctan(\frac{\sin((1-N) * t)}{(R/EN) - \cos((1-N) * t))})) - (E * \cos(N * t)) \quad (\text{Eq-1})$$

$$Y = (-R * \sin(t)) + (R_r * \sin((t + \arctan(\frac{\sin((1-N) * t)}{(R/EN) - \cos((1-N) * t))})) + (E * \sin(N * t)) \quad (\text{Eq-2})$$

(Where, R – radius of rotor, E – eccentricity, R_r – radius of the rollers and N – number of rollers)

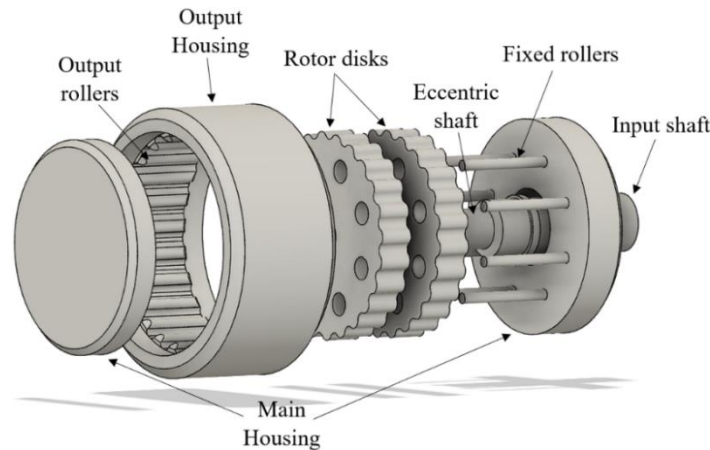


Figure 3 - Cycloidal drive design exploded view

CAD modelling

This robot manipulator contains 5-axis for the movements. Its R_360-axis, R-axis, Z-axis, J-axis and I-axis (Each axis was labeled with letters and numbers for ease of use.). R_360-axis is the main axis that rotate around the main platform while carrying all other axis and it holds whole weight of the robot arm. To get a smoother movement and reduce the axis play a triple cycloidal disk gear system was used instead of dual cycloidal disk design. Crossed roller slewing bearings are used in this design to reduce any friction on output housing. R-axis is linear axis that can vary the radius of robot arm movements and that uses motor rotary movements and converted into linear movement by mean of a lead screw and nut. To grain accurate smooth movements with ability to accommodate heavy axial loads, linear guide rails were used to drive this axis. Z-Axis is also a linear axis that same as the R-axis but in vertically.



Figure 6 - R_360-axis CAD model exploded view



Figure 5 - R-axis CAD model

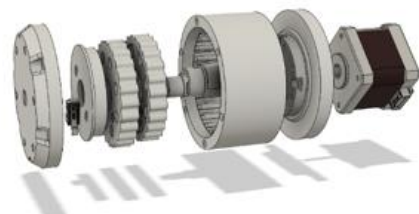


Figure 4 - I-axis CAD model exploded view

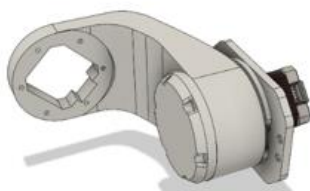


Figure 9 - J-axis CAD model



Figure 7 - Z-axis CAD model

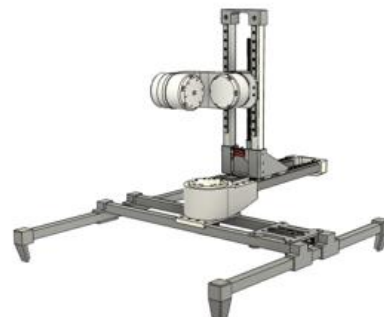


Figure 8 - Robot manipulator full CAD design

This design also used linear guide rails and lead screw setup to drive the joint. J-Axis joint don't have too much load. so, these joint uses two cycloidal disks instead of three cycloidal

disks that attached to eccentric shaft to drive the joint. To carry all radial loads, two ball bearings were used in each side of the output housing. This I-Axis joint work same as the J-Axis joint. In this design main housing back plate is used to mount this joint component to the J-Axis arm. Also, here mechanical limit switches were used to act as end stops for these joints. Fusion 360 3D modeling software were used for the robot manipulator 3D model designing.

Firmware and WIFI serial bridge configuration

A modified open-source firmware, Marlin firmware that available on GitHub under the open-source license (Kory, 2017) is used in this system. Marlin firmware is mainly configured for 3-axis 3D printers. To work with 5-axis manipulator, there have to do some configuration and modification to the firmware. This firmware was developed on the Arduino software and for the configuration and modification of the Marlin firmware Arduino IDE was used. The marlin firmware basically controls all inputs and outputs of the Arduino MEGA according to serial input from the user and firmware algorithm.

The marlin firmware for polar coordinates works mainly with X and Y coordinates. The Z coordinates that receive from the G-code (Geometric Code) works independently with the Z axis. But the X and Y coordinates that the marlin firmware gets from the G-code sender is a cartesian coordinate system that represented by X and Y value. In the polar coordinating system using *R_360(X_AXIS)* and *R(Y_AXIS)* coordinating values to move the axis motors and use to represent the X and Y cartesian coordinates. Because of that some equations are used to convert cartesian coordinates to polar coordinates.

The ESP-link firmware is an open-source firmware that available on GitHub (Jeelabs, 2015). It connects the microcontroller to the local network or the internet using an ESP8266 module. This ESP-link firmware implements a transparent bridge between WIFI and serial communication of the Arduino MEGA. Once the ESP module connected to the desired network it will automatically show its IP address. That IP address can be used to access the ESP-link. Then the ESP module can be attached to the microcontroller and connect Arduino MEGA microcontroller through the ESP-link using port 23 on user computer or laptop. The user has full control of the machine and it can be used as a wired system and it will give ability to control or monitor the machine via any mobile device.

Implementation

Once the CAD modelling was complete, the robot manipulator manufacturing process can be initiated. Most of parts in this robot arm was design to 3D print. 3D printed parts were printed with PETG material. The 3D printed parts may need to clean and sanded to fit together. In this stage some unique designs like cycloidal disks and output housings had to print over and over to test for best fit to archive zero play cycloidal drive. The assembling has done very precisely and carefully with correct orientation of the parts. M3 bolts, nuts and heat inserts were used to fix parts together.

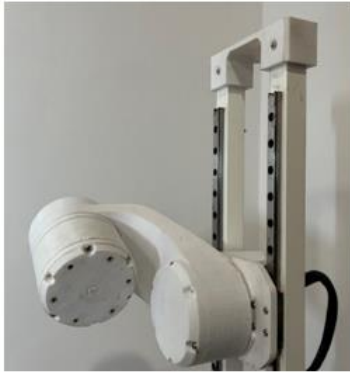


Figure 12 – Robot manipulator I & J axis assembly



Figure 11 - Robot manipulator all 5-axis assembly



Figure 10 - Robot manipulator full assembly

Results and Discussion

For the software simulation of the robot arm MATLAB R2021b software was used. To do the simulation using MATLAB first had to convert the Fusion 360 draft CAD drawing to the SOLIDWORKS 2021. SOLIDWORKS 2021 was used to define the coordinate system of the robot arm. Then the Simscape plugin for the SOLIDWORKS can be used to export Simscape multibody link file. Afterwards that Simscape multibody link file, SOLIDWORKS assembly file and parts files were used to import to the MATLAB software. Once folder path of that files was chosen the Simscape multibody link file can be simulated. Then the below Simulink block diagram was automatically generated via MATLAB Simulink. This block diagram was used to simulate the robot arm simulation environment. A motion study of the designed robot arm were done by changing the motion link variable of the block diagrams. The MATLAB mechanics explorer window was used to monitor the motions of the robot arm. Once the software simulations complete, real world testing was conducted. The real-world testing part was mainly focused on finding hardware limitation of the robot arm. By doing testing, robot arm joint's velocities, accelerations, rotational accuracies and joint limits were calculated and adjusted on the firmware. However, there were some inaccuracies and vibrations were found on the bottom rotary axis due to high payload. But it was reduced by reducing axis maximum velocities and acceleration values. Afterwards there are some plotting testings were done with commonly used patterns (plotting letter 'A' in figure 14).

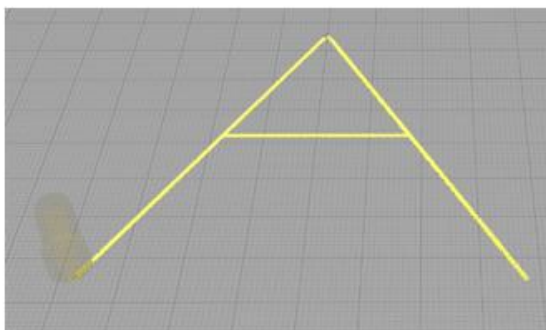


Figure 13 - Sliced drawing for robot manipulator plotting



Figure 14 - Robot manipulator plotted test drawing (with attached pen plotting tool)

Conclusion and Recommendation

It can be seen that there is a place for small-scale 5-dof robot manipulator arm for makers and designers in the industry. As established, the current manufacturing methods of large-scale machining equipment cannot be employed by small-scale manufactures and designers that require for small quantities of manufacturing and prototyping. Since the current methods of manufacturing employed by small-scale manufacturing and prototyping involve using multiple machines for different kinds of works. The time spent and tools that has to be used can get cumbersome.

The designs put forth by this paper offers a suitable solution for an affordable machine that can reduce the time and complexity of manufacturing and prototyping. This is achieved in the paper by introducing a small-scale 5-dof robot manipulator for material handling purposes. This machine offers a five degrees of freedom flexibility for machining and rather than typical cartesian machines this machine uses a poler system that offers a small compact design. Cycloidal drivers were used in rotary joints in order to gain higher torque with small motors. Additionally, this machine can be controlled and check the current status of the machine wirelessly via local network. Also, this machine can be easily work with most common manufacturing software. With some minor changes physical implementation of the machine was built as same as the computer aided drawing that accomplished the design specifications. Also, the expected outcomes were archives while building the machine. As a testing a plotting was done to check the manipulator coordinating system and it was came as expected. Also there had to do many tests 3D prints for the cycloidal drives to check the gear fitting and to reduce the gear play. By working on this project, it was able to gain knowledge about mechanical structures of robotic manipulators and the drive mechanisms that used in robot arm joints, actuator types, electronic components that can work with robot arms. Also get to know about robotic forward and inverse kinematic techniques.

To better introduce this machine to the industry certain improvements on the proposed design can be performed. Improvements that can reduce the overall cost of building the design as well as to make assembly easier. The machine can be built to perform individually without any user computer or laptop by adding a microprocessor system as the brain of the machine. Additionally, since there is no status of the machine can be observed without referring user software, an LCD panel can be added to the machine with included controllers for manual jogging the machine. Also, the wireless controls can be improved to work on any browser interface. So, the user can work on the machine without any software requirements. Other improvements like adding encoders to the joints for more accurate position readings and turn the steppers as feedback-controlled steppers, change the controller board to more advance microcontroller so it can perform more. By doing these kinds of improvements this machine can be introduce to the industry for more advance developments.

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HEALTH SCIENCE

WILL BREAST CANCER FADE AWAY A MOTHER-TO-BE?

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Abstract

Breast cancer is the most ordinary malignancy in women, where its incidence increases with age, with the majority of patients diagnosed after menopause. Also, many young women are diagnosed with breast cancer during their reproductive life. Most breast cancer cases require cytotoxic chemotherapy and/or hormone therapy, which are responsible for a decrease in the patients' reproductive function and age. The effectiveness of such treatments, among other factors, has led to a high five-year survival rate, resulting in an increasing number of young women who survive breast cancer before fulfilling their reproductive wishes.

A variety of fertility preservation techniques has been developed, such as ovarian suppression, oocyte, and embryo cryopreservation, ovarian tissue cryopreservation, immature oocyte retrieval, and in vitro maturation. Early counseling and referral of these patients to fertility specialists are fundamental factors in order to maximize their luck of pregnancy. This review aims to modernize the knowledge about the impact of breast cancer on fertility, the influence of pregnancy and fertility preservation techniques in breast cancer patients, and the assessment of ovarian reserve for a better treatment choice. A special section dedicated to BRCA mutation carriers has been included because of their specific features.

Keywords: *BRCA1, BRCA2, Fertility, Menopause, Breast Cancer*

Introduction

Breast cancer is a disease in which cells in the breast grow uncontrollably. Nearly breast cancers are found in women who are 50 years old or older, but breast cancer also affects younger women. While breast cancer diagnosis and treatment are difficult for women of any age, young survivors may find it overwhelming (Division of Cancer Prevention and Control, Centers for Disease Control and prevention, 2020). There are contrastive kinds of breast cancer which depend on which cells in the breast turn into cancer. A breast is made up of three main parts: lobules, ducts, and connective tissue. The lobules of the breast consist of glands that produce milk. The ducts are tubes that carry milk to the nipple. The connective tissue (which consists of fibrous and fatty tissue) surrounds and holds everything together. Breast cancer can arise in various parts of the breast where most breast cancers begin in the ducts or lobules. Breast cancer can escalate outside the breast through blood vessels and lymph vessels. When breast cancer spreads to other parts of the body, it is said to have metastasized.

In recent decades, obstetricians are having a visual perception of an increase in the number of women who become pregnant or desire to become pregnant after breast cancer treatment because of a delay in childbearing for a variety of reasons, including cultural, educational, and professional. Consequently, breast cancer in young women often occurs before the completion of reproductive plans.

Related Genes and Symptoms in Breast Cancer

BRCA1 (BREast CAncer gene 1) and BRCA2 (BREast CAncer gene 2) are genes that produce proteins that assist repair DNA damage. Everyone has two copies of each of these genes—one copy inherited from each parent. *BRCA1* and *BRCA2* are sometimes called tumor suppressor genes because when they have certain changes, called harmful (or pathogenic) variants (or mutations), cancer can develop. People who inherit harmful variants in one of these genes have enhanced risks of several cancers—most notably breast Cancer. About 13% of women in the general population will develop breast cancer sometime during their lives (Howlader et al.,2017). By contrast, 55%–72% of women who inherit a harmful *BRCA1* variant and 45%–69% of women who inherit a harmful *BRCA2* variant will develop breast cancer by 70–80 years of age (Kuchenbaecker et al.,2017). The risk for any one woman depends on a number of factors, some of which have not been fully characterized. Like women with breast cancer in general, those with harmful *BRCA1* or *BRCA2* variants also have an increased risk of developing cancer in the opposite (contralateral) breast in the years following a breast cancer diagnosis. The risk of contralateral breast cancer increases with the time since a first breast cancer, reaching 20%–30% at 10 years of follow-up and 40%–50% at 20 years, depending on the gene involved. Breast cancer symptoms include: Swelling of all or part of the breast, Skin irritation or dimpling, Breast pain, Nipple pain or the nipple turning inward, Redness, scaliness, or thickening of the nipple or breast skin, Nipple discharge other than breast milk, Lump in the underarm area.

It's always smart and safe to carry out a monthly breast self-exam so you become familiar with your breasts and have a better chance of noticing any alterations. The earlier breast cancer is found and diagnosed, the better your chances of successful treatment you get ([Breastcancer.org.Donate](https://www.breastcancer.org/donate), 2022).

Impact of Surgeries

Scarring is an inevitable outcome of breast surgery. The appearance of the scar depends not only on the extent of the surgery but also on your skin type, your body type, the size of your breast, and the type of surgery you had. This can take more than a year for a mastectomy incision to heal fully. After a lumpectomy, your breast may sense foreign and disturbing to you; it may have a dent, look shrunken, or appear to be pulled to one side. You've been through a very unpleasant and life-changing experience and you're entitled to do what you can to make its aftermath as comfortable as possible. If you are harassed about your appearance months or years after surgery, address to a plastic surgeon about all the possibilities and decide what's best and meant for you.

Most women experience some pain in the weeks after surgery, especially a mastectomy, many will have such pain for years afterward. There are some instances, where pain begins years after the operation. Forty-nine percent of patients who have breast cancer surgery say they have some sort of ongoing pain or occurrence in sensation, and 10% say it interferes with their everyday lives. This pain may be in the mastectomy scar, the arm, or even the muscle under breast. It may be needful for you to consult a pain specialist to get the proper

treatment. Options may include massage, acupuncture, and antidepressants, which have an effect on damaged nerves (F Cardoso, 2019).

Fertility after Breast Cancer Treatments

Can Chemotherapy cause Infertility?

Studies have found that about half of young women with breast cancer say they wish to have a child after completing treatment. But some treatments for breast cancer, such as certain types of chemotherapy, can cause infertility. Having breast cancer treatment may mean you have to think about your fertility sooner than you had planned. While your main concern is probably treating your breast cancer, if having children of your own is important to you then procedures to preserve your fertility – such as IVF or freezing eggs can be offered.

Chemotherapy can cause infertility in women who have not been through the menopause (pre-menopausal). It can affect the performance of the ovaries, reducing the number and quality of eggs. The chemotherapy drugs most probable to have impact on your fertility are a group called ‘alkylating agents’. One of these (cyclophosphamide) is usually used in combination with other chemotherapy drugs to treat breast cancer.

Chemotherapy can cause your periods to stop which may be temporary or permanent. Usually the younger you are when having treatment, and particularly if you’re under 35, the more likely it is that your periods will return. Women over 35 are more likely to lose their fertility after chemotherapy. It’s possible to stop having periods temporarily during treatment and to start having them again later, months or occasionally even a few years after treatment has finished. Even if your periods return after chemotherapy, the menopause is likely to happen sooner (up to 5–10 years earlier) than it would have done if you had not had chemotherapy. This may mean you have a shorter time to try to get pregnant. If your periods do return, it does not always mean you’ll be able to get pregnant, so it’s essential to speak to your treatment team if you have any concerns (Sivestris E et al., 2020).

Can you become Pregnant while taking Hormone Therapy?

Hormone therapies are in used in women whose breast cancer is oestrogen receptor positive (ER+). Some of the most ordinarily used hormone therapy drugs for pre-menopausal women with breast cancer are Tamoxifen, Goserelin (Zoladex) and Aromatase inhibitors (anastrozole, letrozole and exemestane) alongside goserelin (Lauren Smith, MA, 2021).

In most pre-menopausal women who take tamoxifen, the ovaries continue to work. When you start taking tamoxifen it may stimulate ovulation and could make you more fertile. However, getting pregnant on tamoxifen is not recommended. For some women, continued usage of tamoxifen means periods become less regular, lighter or stop altogether. Generally, your periods will start again once you stop taking tamoxifen, as long as you have not gone through the menopause naturally while taking the drug. However, it may take four to five months for your periods to become regular again. Long term use of Tamoxifen also causes endometrial cancer, which is also a factor affecting fertility.

Goserelin cuts off the production of oestrogen from the ovaries. It’s often combined with other hormone therapies used to treat breast cancer, such as tamoxifen or aromatase

inhibitors. Hormone treatment is normally interpreted for five years or longer. While you're taking hormone treatment, you'll be advised not to get pregnant as it may harm a developing baby. Even if your periods stop while you're taking hormone therapy you could still get pregnant.

Strategies to Prevent Infertility from Breast Cancer Treatments

Studies have found that about half of young women with breast cancer say they would like to have a child after complementary treatment. But some treatments for breast cancer, such as certain types of chemotherapy, can cause infertility therefore women chose to freeze their embryos, eggs, or ovarian tissue before undergoing treatment for breast cancer. Common methods of preserving a woman's fertility before starting breast cancer treatment are safe for young women (Ellen Warner et al., 2020).

Table 01 : Fertility Preserving Methods

Characteristic	Option			
	Ovarian suppression	Embryo freezing	Egg freezing	Ovarian tissue freezing
Definition	Monthly injection of gonadotropin-releasing hormone agonist to suppress ovulation and menstruation	IVF and freezing of embryos for later transfer	Hormonal stimulation, harvesting and freezing of oocytes for later fertilization and transfer	Removal and freezing of ovarian tissue and reimplantation of tissue after chemotherapy
Timing	Ideally, start at least 1 week before first chemotherapy treatment and continue until chemotherapy is completed	Before first chemotherapy treatment (or hormone treatment if not chemotherapy given)	Before first chemotherapy treatment (or hormone treatment if not chemotherapy given)	Ideally before first chemotherapy treatment (or hormone treatment if no chemotherapy given)

Treating Breast Cancer During Pregnancy

When you're pregnant, finding out that you also have breast cancer can be overwhelming. At the same time that you're hoping to carry a new life into the world, you enter into a fight to protect your own life. You may be concerned that the treatment you need could harm your baby. Or you may worry that treatment won't be as effective if you're pregnant. As a result of Pregnancy, breasts tend to swell and become tender as milk ducts grow and stretch to prepare for breastfeeding. Because of the swelling, it may be more difficult to detect small lumps. Breast cancer in pregnancy most often presents as a painless mass or thickening in the breast

occasionally associated with discharge from the nipple. About 95% of women are presented with a painless mass (Scott-Connor CE, Schorr S, 1995). Ordinarily, the mean breast weight doubles in pregnancy from 200 g to 400 g, resulting in enhanced firmness and density of the breast, which makes the interpretation of the clinical examination and mammogram results inconvenient. The hypertrophy and engorgement of the breasts may make both physical examination and mammographic imaging more challenging in pregnant than in non-pregnant patients. The preliminary investigation may be performed in non-pregnant women; however, for pregnant women, special attention should be paid to the risks of ionizing radiation exposure for the fetus.

For this reason, women diagnosed with breast cancer during pregnancy tend to have more advanced cancers at diagnosis than other women with breast cancer. Still, most studies show that pregnant women respond to treatment as well as other women of the same age and with the same stage and type of breast cancer. It's essential for you to do everything you can to treat the breast cancer so you can mother your baby for many years to come.

When you are diagnosed with breast cancer while pregnant, your treatment options will be much complicated because you will want to get the best treatment for your cancer while also protecting the baby. When treating a pregnant woman with breast cancer, the goal is the same as when treating a non-pregnant woman: to cure the cancer whenever possible, or to control it and keep it from disseminating if it can't be cured. But the extra concern of protecting a growing fetus may make treatment more complicated.

It is generally safe to have surgery for breast cancer while you're pregnant. Chemotherapy appears to be safe for the baby if given in the second or third trimester of pregnancy, but it isn't safe in the first trimester because a lot of the baby's development occurs during this time thereby the risk of miscarriage is also the greatest during this time (McGrath SE, Ring A, 2011). Other breast cancer treatments, such as hormone therapy, targeted therapy, and radiation therapy, are more likely to harm the baby and are not usually given during pregnancy (Loibl S et al., 2012).

Table 02 : Treatment plan for Breast Cancer during Pregnancy (Keyser, E. A et al., 2012).

Time of Diagnosis	Surgical Treatment	Adjuvant Treatment	After Delivery
1st trimester	Modified radical mastectomy or lumpectomy with axillary node dissection	2nd trimester adjuvant chemotherapy	± Radiation
			± Hormone therapy
2nd trimester/early 3rd trimester	Modified radical mastectomy or lumpectomy with axillary node dissection	± Adjuvant chemotherapy	± Radiation
			± Hormone therapy
		± Adjuvant chemotherapy	
Late 3rd trimester	Modified radical mastectomy or lumpectomy with axillary node dissection	Adjuvant chemotherapy	
		± Radiation	
		± Hormone therapy	

Can breastfeeding be done during cancer treatment?

If you have a baby after breast cancer treatment, you may be questioning if it's safe to breastfeed your baby. You can, as long as you're not receiving chemotherapy or hormonal therapy. If one breast was treated with lumpectomy followed by radiation, it probably won't produce much milk. But don't worry, the breast that didn't acquire radiation can ordinarily make sufficient milk to feed your baby. Whether you breastfeed or not, cuddling and loving your child during feeding time will provide both of you with intimate contact and comfort. The good news is that many studies have suggested that breastfeeding may slightly lower the breast cancer risk, specially if breastfeeding is continued for one and a half to two years or if several children are breastfed (Cohen JM et al., 2009). A possible reason for this may be that both pregnancy and breastfeeding reduce a woman's total number of lifetime menstrual cycles. However, as not all studies support this conception, more research has to be done in this area.

Discussion

As more women postpone childbearing until middle age, the incidence of breast cancer in pregnancy is increasing and delays in diagnosis are more common. It is emphasized that women should undergo periodic breast examinations during prenatal visits. Regarding the treatment options, depending on the time of diagnosis, mastectomy and axillary dissection are

the traditional treatments of choice. Lumpectomy followed by irradiation can be done after delivery. Radiation during pregnancy is best avoided to prevent the risk to the fetus. In addition to their long-term effects, chemotherapy and hormonal therapy have largely been proven to be safe after the second trimester and in the third trimester (Amant F et al., 2013). Women should be advised that premature menopause might result from breast cancer treatments, especially if chemotherapy is given to patients older than 30 years so it's always better to be on the safe side and preserve your fertility before breast cancer treatments. It is recommended that pregnancy should be delayed for at least two years after treatment completion. The recommendation for future conception may be based on the prognosis of individual women. Women with Stage IV disease should not consider pregnancy, and women with Stage III disease should avoid becoming pregnant for at least five years after treatment. Women with recurrent Stage I or II tumors should not consider conception because of the intensity of the required treatment and the poor prognosis.

Conclusion and Recommendations

Early diagnostic methods, targeted therapies, and prolonged survival rates have made fertility preservation a major issue when treating young breast cancer patients. Not only could most young women diagnosed with breast cancer benefit from a wide variety of fertility preservation techniques such as ovarian suppression, oocyte and embryo cryopreservation, immature oocyte retrieval and in vitro maturation, and ovarian tissue cryopreservation, but they could retreat to these treatments without compromising the efficacy of their anticancer therapy.

Women should be well-advised that premature menopause might result from breast cancer treatments. It is suggested that pregnancy must be postponed for at least two years after treatment completion. The recommendation for future conception may be based on the prognosis of individual women. As the data on pregnancy after breast cancer diagnosis and therapy suggest that this can be safe the question regarding fertility preservation before start of treatment needs to be considered in premenopausal women with early-stage breast cancer. The possibility of infertility by the cancer treatment, the possibilities of fertility preservation, and the risk of a subsequent pregnancy need to be addressed in collaboration with a specialist of reproductive gynecology before the start of chemotherapy in all eligible women.

In summary both patients and health care professionals involved in breast cancer should keep in mind that pregnancy after breast cancer is possible and that it can be achieved safely for both mother and child.

Genetic counseling to all patients with pregnancy-associated breast cancer to serve as a guide for future pregnancies is recommended.

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EXERCISE AND WEIGHT LOSS: A REVIEW OF LITERATURE

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Abstract

This study attempts to explore how exercising can aid in weight loss of the human system. This review has done based on various literature published in recent years. The human body consumes energy or calories to move and perform exercise. Exercise helps you burn calories, which aids in weight loss. Cardiovascular exercise is one of the most effective calorie burners than the other types. Furthermore, there are various other factors that can have an impact on the weight loss process. Hence, the amount of weight lost after exercise is less than planned. Energy storage is calculated to discover the gap between energy intake and energy consumption. This secondary research will focus the attention on the discussion on the impact of exercise on weight loss. And discovered how much energy normally needs to be consumed to exercise to lose weight. This review explores the other factors that can have an impact on the ultimate goal of losing weight.

Keywords: Calorie intake, Cardiovascular exercise, Exercise, Weight loss

Introduction

Exercise and weight loss are closely related, as physical activity can help to lose weight. Exercise can increase the number of calories burnt, which reduces the body weight. Burning calories and exercise help to maintain a healthy life and a well-being cardiovascular health and a well-built stress-free life. Weight loss can be affected by different exercise methods, mainly cardiovascular exercise being most important to lose weight. Hence, goals and fitness level can be dependent on this. Intensity and duration of exercise should be given a deep attention when weight loss is expected. Additionally, having a healthy diet of reducing unhealthy foods and beverages is important. Some researchers have identified the factors that influence weight loss, although exercise is essential. As argued in the past articles, normally a sustainable balance between exercise and diet supports for the purposes of weight loss since impacted factors are available.

Methodology

This literature review is descriptive in nature, and it is secondary research which presupposes with the help of secondary data accessible in various research articles, journals, websites and books.

Results and Discussion on Literature Review

Exercise and Weight Loss

Exercise is a physical activity which is planned, structured and repeated for conditioning the human body to improve or maintain physical fitness (Sodergren, et al., 2008). Weight loss on the other hand, is described as a process of reducing body weight which can be done by exercise and a healthy diet. When burning more calories than the foods you get, body begins to use stored fat as the source of energy leading to weight loss which can increase the metabolism. A higher metabolism can burn your calories speedily which contributes to weight loss. Both exercise and weight loss need to be a balanced process.

Cox (2017), found that some research indicated that in a 30-month study of 202 overweight people, those who engaged in activity that burned more than 2,500 calories per week gained less than half the weight of those who did not (2.9 vs. >6 kg). Research also confirms the idea that those who exercise between 150 and 300 minutes per week are less likely to gain weight over time than those who exercise less frequently.

Weight loss was sustained for three years in both high- and low-exercise groups, according to recent studies using the National Weight Control Registry. This demonstrates that there is a great deal of individual variation in how well people can maintain weight loss over time. Researchers discovered that men are better than women in response to exercise, hence men are able to burn more calories through physical activities. It happens with the highlighted hormonal, neuronal effects response to physical activity (Hagobian & Everno, 2013). Belluz & Haubursin (2019), clearly shows by a chart what Hagobian & Everno (2013), has been discovered.

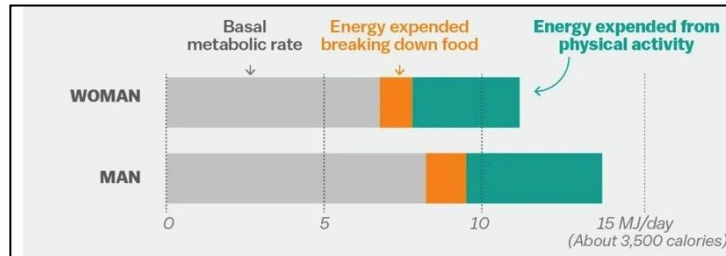


Figure 1: Men lose weight by physical activities than women (Belluz & Haubursin, 2019)

Moreover, it is critical to comprehend how fat is stored. When we consume too many carbohydrates and proteins, they are converted to triglycerides and stored as fat. This discussion is unnecessary in dietary fat. Attempting to lose weight while maintaining muscle mass, you are attempting to metabolize (break down and use) the triglycerides stored in your fat cells. Fat is not lost through energy conversion or heat, contrary to popular belief. It is also not excreted or converted to muscle. As argued by Booth & Laye (2009), most of the research has shown that the lungs are the primary organ for excreting the byproducts of weight loss. Water and carbon dioxide are the byproducts of fat breakdown. But most of the protein, alcohol, and carbohydrates we ingest are broken down into water and carbon dioxide. Water is removed from the body through sweat, breath, urine, feces, and other biological fluids. To use more oxygen and switch to fat burning in order to release more fat through the lungs, we

must activate our muscles. During moderate exercises or light aerobic exercises, your body consumes glycogen (Stored glucose energy). It activates the fat metabolism when it is reduced.

Impact of Exercise on Weight Loss

There is no denying the value of exercise when trying to lose weight. Both diet and exercise are crucial components of a weight-loss plan. Adults who exercised for more than 200 minutes per week (-13.1kg) lost more weight than those who exercised for 150-199 minutes per week (-8.5kg) and those who exercised for less than 150 minutes per week (-3.5 kg) (Swift, et al., 2015).

The amount of exercise to lose weight depend on a few factors, including your current weight, age, and level of physical activity. Generally, the central disease control and prevention (CDC) recommend that adults aim for at least 150 minutes of moderate-intensity or 75 minutes of physical activity per week. This can be broken down into smaller parts of time, such as 30 minutes per day, 5 days per week.

When starting exercise to lose weight newly, the process should be slow otherwise the risk of injury will increase. Hence a professional guidance is compulsory (Liang, et al., 2021).

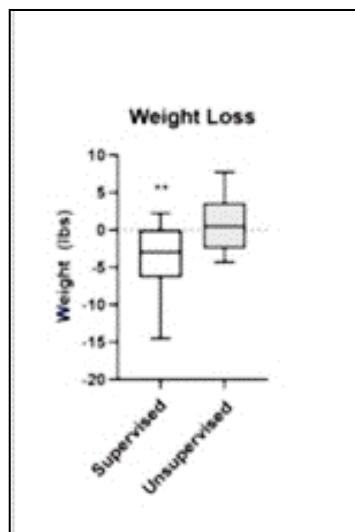


Figure 2: Weight loss under supervised and unsupervised professionals (Liang, et al., 2021)

Cardiovascular exercise is the best exercise method to lose weight than the other types of exercise. The number of calories burnt during cardiovascular exercises like fast walking, running, hiking, dancing, jogging, swimming, and cycling varies depending on how hard you work out, how much you weigh, and how long you work out for (Kandola, 2019; Richards, 2020; Sullivan, 2022). Cardio is important for sustainable health preventing from heart diseases, which controls blood sugar and reduces type 2 diabetes. Heart rate and breathing rate increase during cardiovascular exercise or cardio. Large muscular groups are often used in repetitions during these exercises. Workouts with a moderate level of activity, such as

walking, burn less calories per minute than exercises with a higher level of intensity, like jogging. A walking calorie chart shows how many calories you burn every mile based on your weight and speed. A 160-pound person can burn about 90 calories per mile when walking. Your body burns stored glycogen, accessible blood sugar, and other fuels based on the length and intensity of activity (Kandola, 2019).

Other than Cardiovascular exercise there are other types of exercises causing for this study. Cardiovascular exercise can burn more calories than doing strength training workout of the same duration and effort. Because aerobic exercises can burn more calories when you exercise more. According to (Beaumont Health, 2023) strength training also leads to lose weight which includes push-ups, yoga, climbing stairs, or a stair machine, squats, sit-ups and resistance bands etc. It uses to resistance to build muscles and strength. It is known as resistance training or weight training which helps to lose weight and keep it off by building your muscle tissue. “The more muscle mass you have, the higher metabolic rate tends to be” (Anon., 2023). By building muscle, you can boost your metabolism and burn more fat while exercising. The faster your body burns calories, the more calories it burns throughout each day. Because the weight loss formula is to burn more calories than you consume. Increasing your calorie burn will help you to lose weight. However according to the past research, (Tinsley, 2017) cardiovascular exercise is more efficient in burning calories than strength training which is productive in building your muscles.

Other Factors That Can Impact Weight Loss

Consideration of foods you are taking, it is important to balance exercise and foods you are having daily to lose your body weight. Because weight loss is determined by the balance between the number of calories you consume and burn. Accordingly, if you want to lose weight you need to burn more calories than you consume. As argued by Bumgardner (2021), a calorie is a unit of measurement for both energy expenditure and stored energy. A pound of body fat contains approximately 3500 calories (kcal), though this figure is an estimate. To lose a pound of fat in a week, a generally accepted guideline is to consume 500 fewer calories (kcal) per day than you expend through metabolism and exercise. Beyond what the body burns at resting, physical activity burns calories. Your body's stored energy as well as immediately available energy are used by your muscles.

According to Keijer, et al. (2014), Energy storage is determined with the energy intake and expenditure related with foods.

$$\text{Energy stores} = \text{Energy intake} - \text{Energy expenditure}$$

A larger dose of physical activity or physical activity combined with energy restriction is necessary to produce greater weight loss. As a result, this below graph clearly shows that how important it is to maintain a healthy diet and a good process of exercise in order to weight loss (Isagenix Worldwide, 2022)

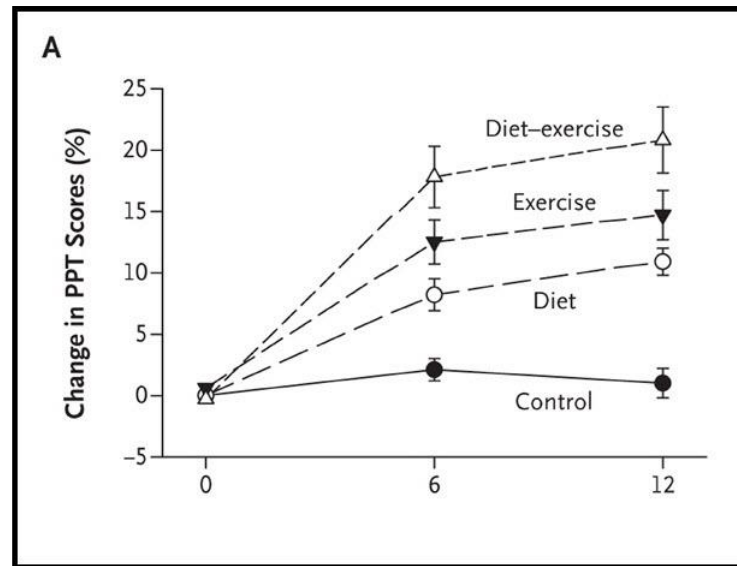


Figure 3: Measured parameters of Physical performance test combined with exercise and diet (Isagenix Worldwide, 2022)

Richards (2020), has discovered several other factors that can impact weight loss. Accordingly, environment and your surrounding could affect to gain weight. The place should be spacious and free from objects. This researcher has discovered Genetic as another factor which can influence the stored fat and energy use. Chronic illness is another factor such as heart disease which can be a barrier to do exercises. Accordingly, Medications and some side effects of drugs can cause to gain weight as well. As discovered by National Institute of Diabetes and Digestive and Kidney Diseases, Age and Sex are also contributing factors that can impact weight loss. Adults with a normal BMI frequently begin to gain weight in their early 20s and keep adding pounds until they are 60 to 65 years old, and body stored fat may also depend on a person's gender which is also evident from the above chart (Figure 1). In women, the hips and buttocks frequently enlarge with fat. Typically, males get belly or abdominal fat. (NIDDK, 2018).

Chemical messengers moving through the blood known as hormones which are created in endocrine glands are one of the major facts. Regarding to (Leigh Ann Scott, M.D., 2023) insulin, thyroid, cortisol, testosterone and estrogen are some of the hormones that can impact with the metabolism. According to (Groves, 2019) polycystic ovary syndrome is a condition binds causing hormonal imbalance, irregular period rotation in females or the development of small cyst on one or both ovaries. Mostly in 7% of adult women can be seen this. “The hormonal imbalances, insulin resistance, and inflammation related to this condition make it difficult for women with PCOS to shed weight” (Groves, 2019). A well-balanced diet that is low in inflammatory foods like refined carbohydrates and highly processed foods but rich in whole foods, protein, healthy fats, and fiber may help with weight loss and certain supplements may also be beneficial for women with PCOS.

Conclusion and Recommendations

Exercise improves the ability of our muscles to oxidize (breakdown) fat. It does so by burning calories and consuming by-products via the breath. Clinicians should educate their patients about reasonable weight loss expectations and importance based on their physical activity program and emphasize that a balanced exercise process with a healthy diet provide numerous health benefits even if weight loss is not achieved. In addition to exercise, a nutritious diet that limits the amount of unhealthy foods and drinks is essential for weight loss. May be exercise cannot be contributed to the ultimate goals that someone's need in order to lose weight on different types of health problems and other causes. It is evident from these studies that cardiovascular exercise is the effective method of exercise to lose weight than the other types. But according to the findings of past research, it is possible to conclude that, 100 percent contribution is not achieved only by exercise since other factors can also impact on the weight loss process. By reviewing the research papers, this study brings a holistic approach on finding a sustainable balance between exercise and foods while also advancing in weight loss objectives with adequate consideration given to other factors that may affect a person's ability to lose weight.

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**MOLECULAR DETECTION OF THE PRESENCE OF BACTERIA IN THE
CABINETS OF FRESH MEAT SHOPS IN SMALL BOUTIQUE STYLE OUTLETS.**

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Abstract

In present society, every city has got a small boutique style fresh meat shop to fulfil the daily need of meat consumption. The cabinets which are used for storing fresh meats and meat products might be contaminated with bacteria and other pathogens. Therefore, these cabinets might be transferring these pathogens to the consumers through the unfrozen meat products. This study has been designed for the identification of such contaminations. Initially, the swab samples were collected from the cabinets of fresh meat shops around the city of Negombo, Sri Lanka. Standard bacteriological method which is the spreading technique were used to culture the bacteria present in the collected samples. Four different types of bacterial colonies were identified in the morphological identification stage. Thus, two monoplex-PCR assays were carried out with using two sets of primers as *E. coli* specific primers and universal bacterial specific primers to detect the cultured bacteria species. Presence of three different bacteria was confirmed by the PCR assay. During the first assay, presence of *E. coli* was confirmed while the remaining cultures are suspected to be of *Enterobacter kobei* and *Salmonella enterica* based on the morphological features through the second assay. But need to confirmed by specific PCR assays or sequencing analysis. Food spoilage and the food-borne diseases are the two biggest impacts that can cause health hazards to the consumers. The diseases caused by them could vary from mild to severe conditions. But the most dominant impact caused by these bacterial species is the large scale food poisoning. There have been reported incidence of food poisoning of large groups of people leading to significant number of deaths (Bajaj & Dudeja, 2019).

Keywords: Bacterial pathogens, *E. coli*, Infections, Molecular detection, Monoplex-PCR, Primers

Introduction

Fresh meat shops in small boutique style outlets have become most common within today's suburbs and rural societies where frozen food is not commonly available. These cabinets have been adopted to store unfrozen meat products and meat. Yet these cabinets are not 100% sterilized from microorganisms. Thus, it leads to the contamination of stored meat and meat products (Anon., 2022)

This study was conducted within the city of Negombo, Sri Lanka; where these small boutique style outlets are managed by single owners on daily basis. Chicken is the most common meat sold in Negombo while beef, pork and mutton are being sold in small scale.

The contaminated unfrozen products which are displayed for sale in the cabinets of the fresh meat shops are a good reservoir for the growth of pathogens as well as a good source of the food-borne diseases/illnesses (Aydin, et al., 2011) (S. Wu, et al., 2018). As a result of consuming these contaminated meat products, people can be infected by these food-borne diseases. The most significant type of pathogens that can be found within these cabinets are

the bacterial pathogens (Flores, et al, 2012). Accordingly, the molecular detection technique can be adopted for this study in order to identify these bacterial pathogens.

The fundamental objective of carrying out this study on “molecular detection of the presence of bacteria in the cabinets of fresh meat shops in small boutique style outlets in Sri Lankan market” is to identify the presence or absence of bacterial pathogens within the cabinets of fresh meat shops by using the monoplex-PCR process as the molecular detection technique.

Methodology

Five different fresh meat shops in Negombo were selected for this study. The swab samples were collected from meat cabinets according to the WHO standards. Three swab samples were taken from each meat cabinet and stored at -20 °C.

The samples were then cultured using LB media according to the L.B. Miller formulation. Samples were spread on the surface of the plates using spread plate method and incubated for 24 hours at 37 °C. Bacteria growth on plates were observed at regular intervals and morphology of the colonies were recorded.

Then the DNA extraction was conducted by following the boiling method to isolate DNA from bacterial colonies. Quantification was carried out by using nanodrop spectrophotometer in order to determine the quantity and the quality of the extracted DNA samples prior to PCR analysis.

PCR analysis was conducted by using *E. coli* specific primers and universal bacteria primers for mitochondrial 16S rRNA gene amplification. PCR products were analyzed by agarose gel electrophoresis.

Results:

Culture results:

Figure 1: Observed colonies from sample cabinet 01.



Figure 2: Observed colonies from sample cabinet 02.

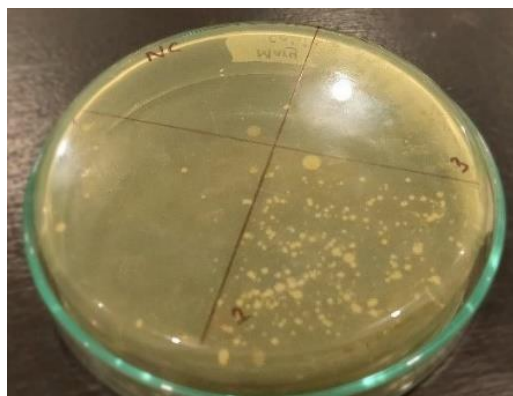


Figure 3: Observed colonies from sample cabinet 03.



Figure 4: Observed colonies from sample cabinet 04.

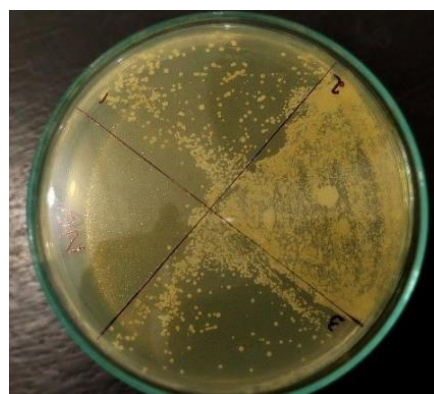


Figure 5: Observed colonies from sample cabinet 05.



Four colonies were observed as below table 1.

Table 1: Colonies picked and their respective sample tubes.

Tube Labelled Number	Colony Color
1.	White
2.	Pink
3.	Yellow
4.	Grey
NC.	Negative control

PCR amplification and gel electrophoresis results:

***E. coli* detection PCR and gel electrophoresis results:**

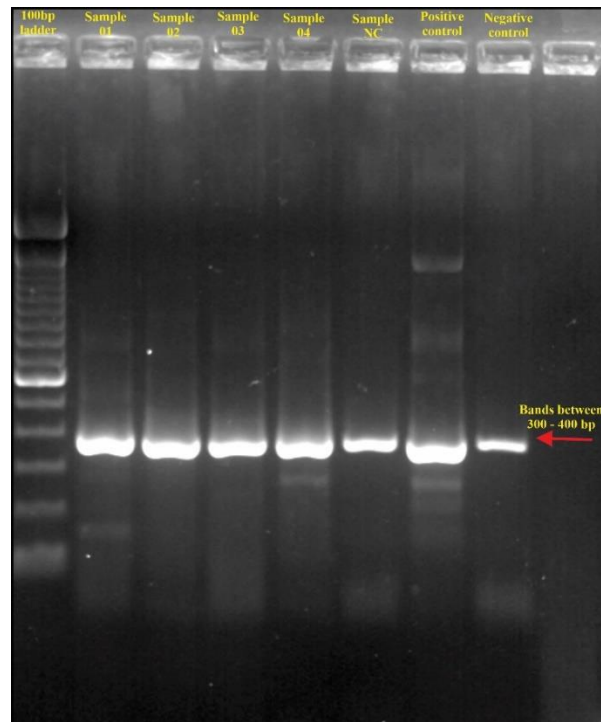
Figure 6: Gel image of the results of PCR amplification for *E. coli* DNA.



In figure 6 compared to 100 bp ladder in 1st lane, four 101 bp bands were observed in lane 2, lane 3, lane 4 and lane 7 respectively. The band of 101 bp reveals the specific nucleotide sequence for *E. coli*.

Universal bacteria detection PCR and gel electrophoresis results:

Figure 7: Gel image of the results of mitochondrial 16S rRNA gene amplification with UNIBAC primers.



In figure 7 compared to 100 bp ladder in 1st lane, five strong bands were observed between 300bp to 400bp in lane 2, lane 3, lane 4, lane 5 and lane 7 respectively. Two weak bands were observed in lane 6 and lane 8. The band between 300bp to 400bp reveals the mitochondrial 16S rRNA gene

Discussion

In this study monoplex-PCR was adopted as the molecular detection technique for the identification of the cultured bacteria. This monoplex-PCR is highly sensitive as well as a rapid technique that can be used for the identification of bacteria. Since four different bacterial colonies were identified using morphological observations, two PCR assays were carried out to detect the type of bacteria. Accordingly, two different sets of primers were used in this study. Universal Bacterial (UNIBAC) primers and the *E. coli* primers (Rice, et al., 2007) were selected since the samples were from the inner walls of the cabinets. This is because, bacterial colonies were formed during culturing and through the morphological observations, it was suspected presence of *E. coli* and some other bacteria.

Thus, prior to the molecular detection of bacteria, morphological identification was done on these bacterial colonies (Jeanson, et al., 2015). Hence, four different colonies were identified through morphological identification as glistening white circular bacterial colonies, glistening yellow circular bacterial colonies, glistening pink circular bacterial colonies and glistening grey irregular form bacterial colonies (Mamou G., et al., 2016). Due to the morphological

identification of four different colonies, it was assumed that there might be four different types of bacteria present. Hence, these four bacterial colonies were used for the extraction of bacterial DNA in order to identify them through the PCR process.

According to the study, samples taken from cabinet 01, 02, and 03 were positive for *E. coli* and sample taken from cabinet 04 is negative for *E. coli*. All the samples were positive for UNIBAC and thus sample taken from cabinet 04 contained bacteria other than *E. coli*.

However, faint positive bands were obtained for sample NC and the (-)ve control. This is mainly because the intensity of the Taq polymerase enzyme gets increased once reacted with the UNIBAC primer (Heininger, et al., 2003).

Accordingly, it was determined that different bacteria are present in the cabinets of the fresh meat shops in small boutique style outlets. The bacteria species observed on cabinet No 01, No 02 and No 03 was *E. coli* and the species observed on cabinet No 04 might be *Enterobacter kobei* and *Salmonella enterica*. To confirm the bacteria species PCR products should be sequenced.

The two biggest impacts on the health of human beings by the activity of microbe on food are the food-borne diseases and the food spoilage, and the diseases caused by consuming of spoiled food or else the food-borne diseases can range from the mild to severe conditions in some cases, it can be fatal. (Batt, 2016) (Desta Sisay, 2015).

Conclusion & Recommendations

Different types of bacteria were identified from the cabinet's swab samples as *E. coli*, *Enterobacter kobei* and *Salmonella enterica*. To confirm the species PCR products should be sequenced. Therefore, the presence of bacteria within the selected cabinets of fresh meat shops in small boutique-style outlets was confirmed.

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MONOGENIC OBESITY; TREATMENT VIA GENE-EDITING

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Abstract

Obesity is excessive fat storage leading to high Body Mass Index (BMI). The global incidences of monogenic obesity increase annually. Monogenic obesity occurs due to a single gene mutation leading to heterogeneous conditions. Hypothalamus controls food consumption via the leptin-melanocortin pathway. Although there are existing treatments for monogenic obesity caused by LEPR deficiency and α MSH mutation, there is no specific long-term cure for the MC4R point mutation. The objective of this review is to evaluate the suitability and feasibility of the already existing gene-editing CASPR/Cas9 method to correct the MC4R gene mutation which is responsible for monogenic obesity. Several search engines and keywords were used to search the relevant content. Proper referencing and citation addition were done using appropriate software. Original journal and review articles were considered since 2011. Diagnosis and confirmation of the specific mutation and the methodology of the novel treatment is suggested along with its benefits and controversies. In conclusion, CRISPR/Cas9 allows transgene migration and rAAV transduces both dividing and non-dividing cells which make them ideal to correct the MC4R point mutation.

Keywords: CRISPR/Cas9, Gene-editing, Leptin-Melanocortin pathway, MC4R gene mutation, Monogenic obesity.

Introduction

Obesity is a life-long, progressive, life-threatening, genetically related, multi-factorial disease of excessive fat storage. A person is considered overweight and obese if their BMI is greater than or equal to 25 kg/m² or 30 kg/m², respectively (El-Sayed Moustafa and Froguel, 2013). Its worldwide prevalence has been greater than twice since 1980s. In 2008, 1.5 billion overweight adults were present. Among them were 200 million men and 300 million women. In 2010, 43 million children below 5 years were overweight. In 2013, 224 million children between 5 and 7 years were obese or overweight. In 2016, 1.9 billion adults were overweight and among them, 650 million were obese. **Figure 1** shows the obesity rates by country in 2021 (World Population Review, 2021). Moreover, this condition is rising in countries at rates above 30% than in developed countries due to their westernized life-style. One out of 10 adults are obese in the world. **Figure 2** shows the obesity and overweight prevalence in Sri Lanka (Global Obesity Observatory, 2021).

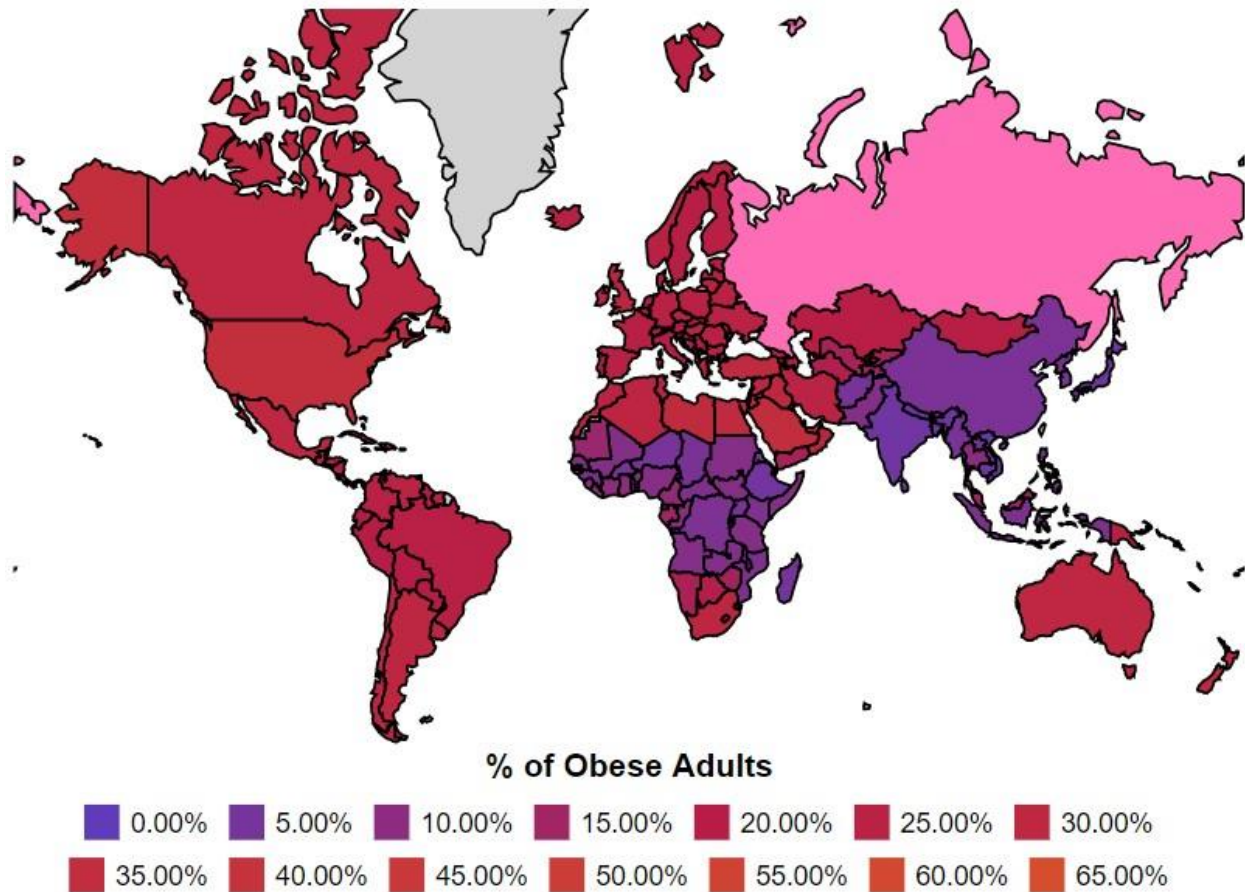


Figure 1: Obesity rates by country in 2021 (World Population review, 2021).

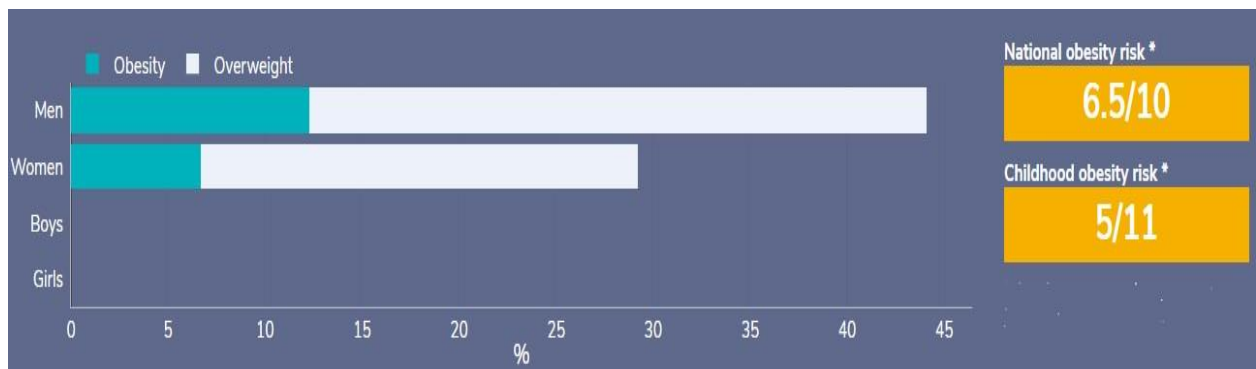


Figure 2: Obesity & overweight prevalence in Sri Lanka (Global Obesity Observatory, 2021).

Obesity can be genetically classified as syndromic and non-syndromic. Monogenic obesity falls under the non-syndromic category. A single mutation leads to monogenic obesity which is a heterogeneous group of conditions in which the body's energy homeostasis is changed (there is high food intake and low energy expenditure) (Huvenne *et al.*, 2016).

The leptin-melanocortin Pathway

The leptin-melanocortin pathway plays a critical role in the hypothalamic control of food intake. The orexigenic path stimulates the appetite and the anorexigenic path suppresses the appetite. The Paraventricular Nucleus (PVN) has a band of neurons in the anterior of the hypothalamus. The arcuate nucleus has a neuronal aggregation in the mediobasal hypothalamus (Clément, Mosbah and Poitou, 2020).

Adipose tissue secretes leptin which binds to its receptor. This inhibits the NPY/AgRP protein, but stimulates the POMC protein to secrete α - and β -MSH (via the processing of PC1/3 and CPE) which binds to MC3R and MC4R. MRAP2 reduces the responsiveness of MC4R activity. Thus, the orexigenic path is provoked. SIM1 facilitates the responsiveness of MC4R which stimulates BDNF production. BDNF binds to its receptor, thus the anorexigenic path is induced. If there is a MC4R deficiency, the anorexigenic path will be less-functional, resulting in obesity through only the orexigenic path. Further, the leptin-leptin receptor complex stimulates the JAK/STAT3 path via the processing of TUB and facilitation by SH2B1. STAT3 then moves to the arcuate nucleus to activate its relevant genes (Proenc *et al.*, 2017). **Figure 3** shows the functioning of the process. **Table 1** shows the outcomes of a single mutation in a gene encoding any of these proteins (Proenc *et al.*, 2017).

The object of this study is to correct the *MC4R* point mutation *in vivo* and *in vitro* using the CRISPR/Cas9 technology. The verification of the feasibility of this treatment technology is another objective. The hypothesis would be that gene-editing by rAAV would be a better treatment to correct the *MC4R* point mutation.

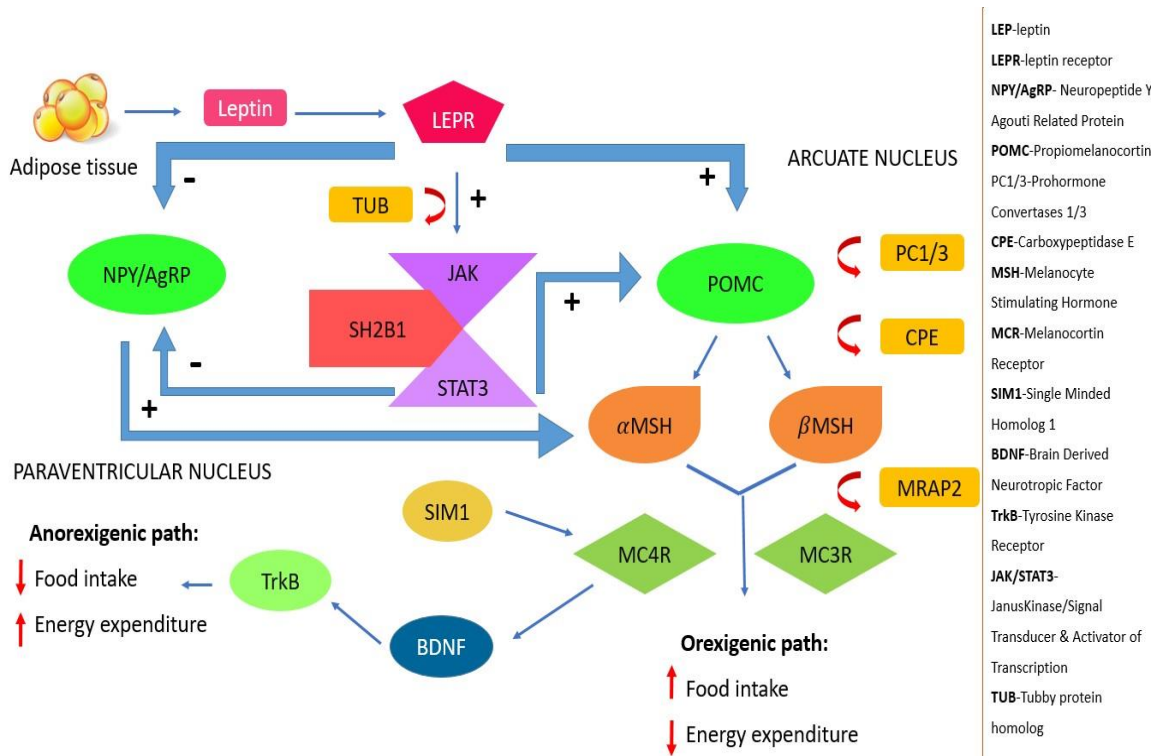


Figure 3: The Leptin-Melanocortin pathway.

Gene	Mutation	Inheritance	Chromosome location	Protein function	Prevalence	Physical presentation	Biochemical presentation	Reference
<i>LEP</i>	Homozygous	Autosomal recessive	7q32.1	Anorexigenic pathway stimulation. Orexigenic pathway inhibition.	27 patients worldwide. More than 50% of Pakistanians	Severe hyperphagia, reduced satiety feeling. Early-onset obesity within one year of age. Quick weight gain during childhood & adolescence. Hypogonadotropic hypogonadism. Hypothalamic hypothyroidism with puberty delay.	Indetectable/ reduced (bioinactive) leptin. Fasting hyperinsulinemia. Reduced/normal FSH, LH. Reduced TRH, elevated (bioinactive) TSH, reduced T4. Reduced or normal GH. Decreased CD4 cells & T-cell responsiveness.	Funcke, 2014

<i>LEPR</i>	Homozygous mutation or heterozygous compound mutation	Autosomal recessive	1p31.3	Leptin receptor	3% within severely obese children from cohort enriched in consanguineous families.	Severe hyperphagia, reduced satiety feeling. Early-onset obesity within one year of age. Quick weight gain during childhood & adolescence. Hypogonadotropic hypogonadism. Hypothalamic hypothyroidism with puberty delay.	Heightened/normal leptin. Fasting hyperinsulinemia. Decreased/normal FSH, LH, estradiol, testosterone. Reduced TRH, greater (bioinactive) TSH, reduced T4. Decreased/normal GH. Less CD4 cells & T-cell responsiveness.	Saeed, 2014; Durben, 2012
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<i>POMC</i>	Homozygous mutation or heterozygous compound mutation	Autosomal recessive/ dominant	2p23.3	Protein precursor of melanocortin family which transmits leptin effects to MC4R and regulates the adrenal growth	19 patients	Hyperphagia. Obesity (or normal range BMI when intestinal phenotype is predominant on appetite phenotype). Intestinal dysfunction Malabsorptive diarrhea. Postprandial hypoglycemia. Central hypothyroidism. Hypogonadotropic hypogonadism. Diabetes insipidus.	Elevated POMC/low or normal ACTH (basal and stimulated)/ less or normal cortisol (basal & stimulated). Heightened proglucagon/normal GLP-1 and GLP-2. Greater postprandial proinsulin/kess postprandial insulin. Hypoglycemia (OGT test). Low-normal TSH. Less or normal T4.	Mandiratta, 2011; Kühnen, 2016
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<i>MC4R</i>	homozygous or compound heterozygous or heterozygous mutation	Autosomal co-/dominant	18q21.3	anorexigenic and orexigenic effect transmission. Controls satiety and energy expenditure.	3-5% among children possessing earlyonset severe obesity	Hyperphagia. Earlyonset obesity. Fast weight gain during childhood & adolescence. Greater linear growth & height. High bone mass. Greater fat & lean mass.	Hyperinsulinemia. High-normal TSH, low-normal T4.	Doulla et al., 2014; Melchior et al., 2012; Farooqi, 2015
<i>MC3R</i>	Heterozygous				22 patients	Obesity. Pathogenic function of <i>MC3R</i> needs further investigation.	No specific biochemical phenotype identified.	Clément, Mosbah and Poitou, 2020
<i>MRAP2</i>	Heterozygous	Autosomal dominant	6q14.3	melanocortin receptor regulation	4 patients	Hyperphagia. Earlyonset severe obesity. Acanthosis nigricans. Advanced bone age with increased growth in childhood & greater final height in adulthood.	Hyperinsulinemia. High-normal TSH, low-normal T4.	Asai,2013; Schonnop, 2016

<i>SIM1</i>	Translocation between chr 1p22.1 & 6q16.2 or 6q16.1q21 deletion or heterozygous mutation.	Autosomal dominant	6q16.3	regulates the development and function of PVN	<i>Translocation:</i> one case <i>Deletion</i> : 45 patients. <i>Mutation:</i> 21 patients	<i>Translocation:</i> greater birth weight. Greater linear growth with advanced bone age. Normal development. No facial dysmorphisms.	Fasting hyperinsulinemia, mild reduction of cortisol consistent with obesity.	Ramachandrapa, 2013
<i>BDNF</i>	Heterozygous 11p1311p15 deletion or inversion	Autosomal dominant	11p3	Regulates the development, survival and differentiation of neurons.	5 patients worldwide	Hyperphagia. Severe obesity. Cognitive impairment. Behavioural abnormalities. Hyperactivity.	Less BDNF. Fasting hyperinsulinemia.	Gray, 2006
<i>NTRK2</i>	Heterozygous	Autosomal dominant	9q22.1	BDNF receptor	only one reported incident, related to severe obesity.	Hyperphagia. Early-onset obesity. Development retardation. Impairment of short-term memory. Impaired nociception.	Fasting hyperinsulinemia.	Yeo, 2004

<i>SH2B1</i>	Heterozygous mutation or 1p11.2 deletion	Not yet elucidated	16p11.2	Modulates signalling in response to leptin and other hormones.	<i>Mutation:</i> 0.8% among severe earlyonset obese individuals. <i>Deletion :</i> 0.7% within morbidly obese individuals	<i>Mutation:</i> Hyperphagia. Severe early-onset obesity. Insulin resistance (acanthosis nigricans). Type 2 diabetes in adolescence. Reduced adult height.	Fasting hyperinsulinemia	Doche, 2012; Rui, 2014
<i>KSR2</i>	Heterozygous mutation (one case comprises a compound heterozygous mutation)	Not yet elucidated	12q24	role in cellular fuel oxidation.	2% of the cases within unrelated severely obese people	Hyperphagia. Earlyonset obesity. Severe insulin resistance. Low heart rate. Less basal metanolic rate	Elevated fasti insulin. Increased Cpeptide	Pearce, 2013

<i>PCSK1</i>		Autosomal recessive/dominant	5q15	Proteolytic processing of prohormones and proneuropeptides		Diabetes insipidus. Malabsorptive diarrhoea. Hypogonadism. Hypothyroidism	Growth hormone Deficiency Adrenal insufficiency.	Martin, 2014; Harter, 2016
<i>TUB</i>		Autosomal recessive	11p15.4	Modulates anorexigenic neuropeptides		Retinal dystrophy		Dev Borman, 2014
<i>LRP2</i>		Autosomal dominant	2q31.1	Binds to long-form of LEPR and activates STAT3 signaling		Puberty delay. Short term memory. Impaired nociception		Paz-Filho, 2014

A single point mutation in the *MC4R* gene causes MC4R protein deficiency which is inherited in a dominant pattern, thus the phenotype is always expressed. It is the most common monogenic obesity form without a proper treatment. If left untreated, it is life-threatening as it can lead to diseases such as diabetes insipidus. A social stigma is created where the fat people are humiliated and discriminated, leading to depression (Proenc *et al.*, 2017).

Existing Treatments

Metreleptin is a leptin therapy which restores gonadal function, yet it is useless in LEPR deficiency. Setmelanotide is an emerging α MSH analog therapy that stimulates MC4R. Weightloss by life-style intervention is effective in *POMC* and *MC4R* loss-of-function mutations, however, this weight loss is difficult to be maintained. Metformin is a rational therapy for patients with *KSR2* mutation (Wang, Tai and Gao, 2019).

CRISPR/Cas9 in Gene-editing

CRISPR/Cas9 is an RNA-guided programmable nuclease that generated site specific double stranded breaks (DSBs). It stimulates Homologous Recombination (HR) and enables transgene migration for gene therapy (Bak and Porteus, 2017).

rAAV is a viral vector derivative of non-pathogenic single-stranded DNA (ssDNA) that can transduce both dividing and non-dividing cells. They can be used as vectors for HR (Bak and Porteus, 2017).

Single-guide RNA (sgRNA) target sites can be reconstituted in the genome after integration. There is no necessity to serially transfect and transduce cells, thus it is a single-step process. Intracellular HR machinery naturally repeats the procedure; hence this enhances high HR rates (Bak and Porteus, 2017). **Figure 4** shows the mechanism of CRISPR/Cas9 in gene-editing (Marzo,2019).

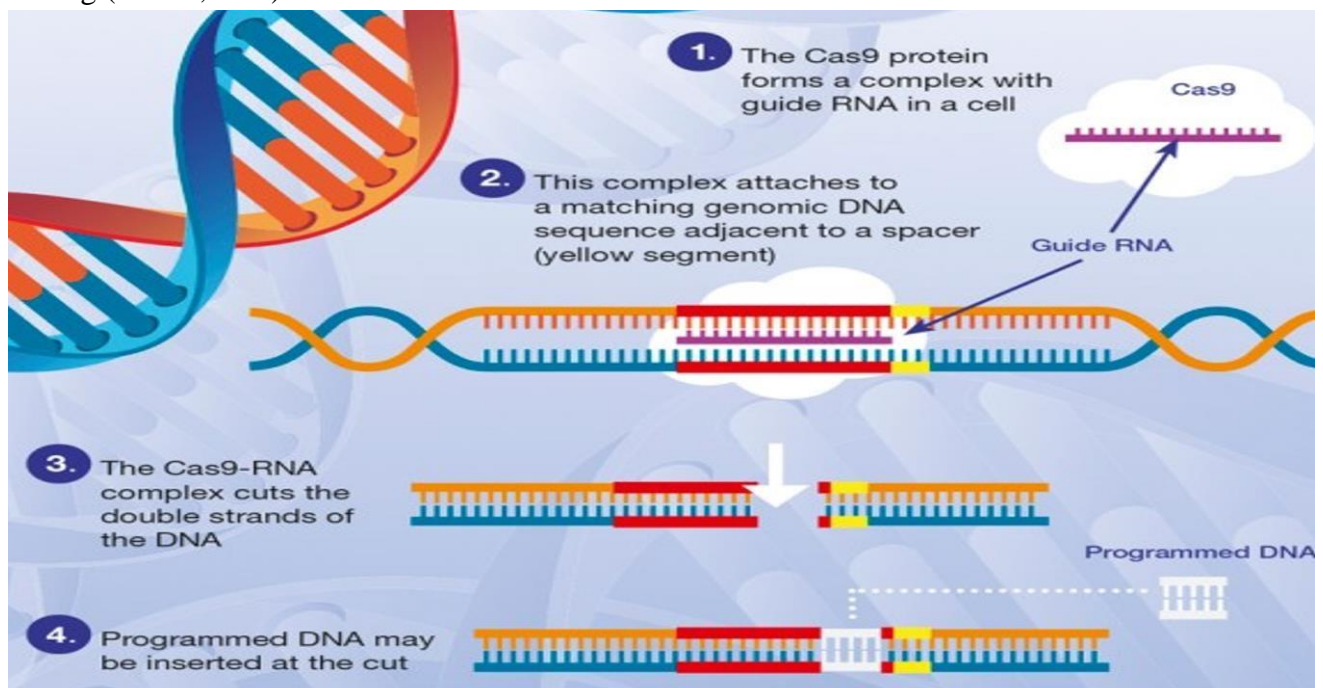


Figure 4: CRISPR/Cas9 mechanism in gene-editing (Marzo,2019).

Current Treatments via Gene-delivery

Existing treatments mainly target the liver, striated muscles and the Central Nervous System (CNS). There are 145 clinical trials registered at Clinicaltrials.gov since 2018. The two drugs in commercial use are Luxturna and Gylbera. Luxturna is the first Food and Drug Authority (FDA) approved rAAV drug for monogenic vision loss by *RPE65* mutation. Gylbera treats the lipoprotein lipase deficiency. Additionally, direct intraparenchymal rAAV injections are given to treat CNS diseases. There are ongoing trials to treat haemophilia A & B (targeting the liver), Huntington's disease by gene-silencing and Duchene's Muscular Dystrophy (targeting muscle cells) (Wang, Tai and Gao, 2019).

Discussion

A single base substitution (C142,CCT→TCT) leads to a homozygous dominant missense mutation in which Serine substitutes Proline at the 48th codon. This causes congenital MC4R deficiency which shows Mendelian patterns of inheritance that results in severe-early onset obesity (Miraglia del Giudice *et al.*, 2002).

Deep-phenotyping and genetic testing are the strategies to identify the *MC4R* point mutation. If a child has severe-early onset obesity, normal psychomotor development, feels hyperphagia, seems taller and has a less risk of hypertension, then check for endocrine anomalies in their early morning samples of insulin, Thyroid-Stimulating Hormone (TSH) and Thyroxin (T4). If there are such anomalies, then Next-Generation-Sequencing (NGS) is done to confirm the *MC4R* point mutation (Huvenne *et al.*, 2016).

Two sgRNAs that can recognize the sense and antisense DNA strands have to be created. These should be inserted into the vectors. The outcome will be a greater cleavage efficiency of sgRNAs and a greater specificity of sgRNA recognition. Furthermore, a donor has to be designed to introduce a T to C point mutation. A synonymous mutation in donor's corresponding sgRNA site has to be introduced too. Thus, sgRNA-Cas9 mediated cleavage is avoided (Zhu *et al.*, 2021).

Gene-editing to treat *LEP* point mutation had been done *in vitro* and *in vivo*. Such evidences from research articles aids the approval of the suitability and feasibility of CRISPR/Cas9 gene-editing procedure to correct the *MC4R* mutation in which both of these genes are involved in the correction of the leptin-melanocortin pathway. There were four steps *in vitro*:

1. A 12-hour *ex vivo* culture was done to identify and isolate the primary preadipocytes of obese mice.
2. Sanger sequencing identified the C to T point mutation in exon 2 of the *LEP* gene.
3. CRISPR/Cas 9 system accomplished the Homology Directed Repair (HDR) of an R102X mutation. Here, a control group was established to avoid false positives due to the presence of Single Nucleotide Polymorphisms (SNPs). Sanger sequencing verified the correct substitution of the new base. T7 Endonuclease I (T7EI) indicated that there were no off-targets. The CRISPR/Cas9 system was highly active as it induced mutations at a greater frequency (75.43±1.55%).
4. The leptin concentrations in the mature culture supernatant and the control group were measured. Their leptin concentrations were 573.4 ± 51.3 pg/ml and 30.2 ± 1.5

pg/ml, respectively. It is evident that the leptin production has been significantly restored in the genetically edited preadipocytes (Zhu *et al.*, 2021).

The same experiment was done *in vivo*.

1. The AdvCas9-sgRNA virus and AdvDonor were injected to the adipose tissue of *ob/ob* mice. This had an efficiency of more than 90%. TA (repeated) cloning showed that the Homology Directed Repair (HDR) efficiency was 1.67%. Nested Polymerase Chain Reaction (PCR) indicated that there were no off-targets.
2. Immunohistochemistry and *in situ* hybridization indicated that there were detectable leptin concentrations by the edited adipose tissue. Hemotoxylin and Eosin (H&E) staining showed that there were no inflammatory or neoplastic changes in the adipose tissue due to the rAAV infection. There was a decrement in body size, bilateral inguinal adipose tissue volume, food intake and weight, thus obesity was ameliorated. Glucose and lipid metabolism diseases were improved because there were inhibitory effects on the Total

Cholesterol (TC), Triglycerides (TG) and the Low-Density Lipoprotein Cholesterol (LDLC) levels and the liver weighed less (Zhu *et al.*, 2021).

Advantages

1. AdvCas9-sgRNA virus and AdvDonor is greatly efficient in infecting mammalian cells as it does not cause any diseases or cellular alterations.
2. This technology directly converts one base pair into another without generating Double-Stranded-Breaks (DSBs).
3. The modification of the DNA base-editor design has highly enhanced the editing efficiency, accuracy and the flexibility.
4. It is a versatile tool for precision medicine to improve therapeutic solutions targeting various genetic diseases.
5. CRISPR/Cas9 system is very specific without any noticeable off-targets.
6. It is a radical treatment tactic for monogenic diseases and is perfect for clinical backgrounds with inadequate conventional treatments.
7. DNA base editors have an RNA-guided, catalytically inactive form of Cas which is useful to recognize the correct sequence. It also has a fused effector to acquire base conversion (Zhu *et al.*, 2021).

Limitations

1. The major issue is that this technology is very expensive, attributed to the high manufacturing cost, the too many resources and expertise needed.
2. Immunological barriers such as the defence against AAV is another disadvantage. Yet, this can be overcome by the total elimination of the viral coding sequence. Thus, the packaging capacity of rAAVs can be maximized and there will be a low immunogenicity and cytotoxicity produced when delivered *in vivo*.
3. Intracellular trafficking of rAAV encompasses numerous cellular proceedings and may halt at any step causing failed gene delivery. However, this can be compensated by recognizing the key host cellular factors and considering the mechanisms that

control the process to increase the rAAV transduction efficiency (Matharu *et al.*, 2019).

Although the CRISPR/Cas9 gene-editing procedure appears to be impractical due to its high cost and multiple resources needed, this is the most suitable treatment to acquire a long-term cure efficiently and with great specificity. Drawbacks such as immunological barriers and intracellular trafficking can be overcome by using immunosuppressive drugs and empty capsids for anti-AAV antibody adsorption.

Conclusion

In summary, there are no existing specific treatment for the *MC4R* gene mutation which is very abundant among obese people around the world. Gene-editing is the most suitable mechanism to correct the mutation in such patients. As a result, their food consumption will lessen and their energy expenditure will be facilitated. The designated limitations have been overcome in the previous gene editing treatments and it has been proved that this strategy can be used to treat monogenic disorders. Only Luxturna (to obtain partial vision in blind people suffering from a monogenic mutation) and Gylbera are the only two products in human practice due to the high cost of developing these treatment methods. The target tissue to correct the *MC4R* point mutation is the PVN of the hypothalamus. However, if the injection to this site is unreachable, it would be better to design a radiolabelled monoclonal antibody which will bind to the specific target. This would also enable the monitoring of the AdvCas9-sgRNA virus and AdvDonor delivery.

Therefore, considering all of the above facts and evidences, the better viewpoint is to accept the hypothesis mentioned in this review.

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AN OVERVIEW ON POST DISEASE COMPLICATIONS OF COVID-19

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Abstract

Research suggests that a subset of patients continue to show symptoms and, in some cases, develop new conditions after recovering from COVID-19. To that end, 56 relevant scholarly articles were evaluated from which this review intends to shed some clarity on the topic by discussing these complications under different organ systems. The identified respiratory complications include general conditions like fatigue and dyspnea. The virus may also increase vulnerability to other infectious respiratory diseases. Cardiovascular complications include thromboembolism and major adverse events like heart failure. Gastrointestinal complications include common conditions like nausea and vomiting. Metabolic-associated fatty liver disease can be considered a rather serious gastrointestinal complication. Renal complications include acute kidney injury and end-stage kidney disease, with steep declines in eGFR also observed. Neuropsychiatric complications include psychiatric conditions like anxiety and depression, as well as central and peripheral nervous system related issues. In most cases, these post-disease complications are associated with the severity of COVID-19. The pathophysiology behind these complications is yet poorly known.

Keywords: Post-COVID-19 Syndrome, Post-disease Complications, Post-COVID-19 Manifestations

Introduction

COVID-19 is a respiratory illness caused by the SARS-CoV-2 virus which rapidly spread across the globe to the point where it was declared a pandemic by the World Health Organization (WHO) (WHO, 2020). While efforts to control the spread of the virus and to treat those affected have been successful, research suggests that some patients continue to experience symptoms and develop new conditions long after their PCR test is deemed negative (Suvvari et al., 2021). These complications that develop during or after infection, which persist for more than 12 weeks, are lately characterized under “Post-COVID-19 syndrome (NICE, RCGP, and SIGN, 2022). Since a considerable population has been infected by and recovered from COVID-19 in the recent past, it is imperative to understand the post-disease complications of COVID-19 in order to better manage patients and spread awareness. This review focuses on analyzing these complications by classifying them under respiratory, cardiovascular, gastrointestinal, renal, and neuropsychiatric complications.

Methodology

For the purpose of this review, a systematic review of the available literature was conducted using several databases and search engines. Numerous articles were referred from which a total of 56 articles were selected and evaluated for inclusion based on their relevance and the quality of their methods and findings. The articles were then organized and analyzed

according to their focus on specific organ systems from the results of which this review was developed.

Results and Discussion

Respiratory Complications

A predominance of respiratory complications is seen among COVID-19 survivors (Santis et al., 2020). The most common symptoms observed are fatigue and dyspnea. In many cases, these general symptoms may indicate the presence of more severe underlying respiratory problems (Jakubec et al., 2022). Studies have found that a high proportion of patients experience these symptoms, with rates ranging from 47% to 87% for fatigue, 32% to 71% for dyspnea, and 18% to 29% for cough (Goërtz et al., 2020, Aiyegbusi et al., 2021). Research also suggests that due to an immunosuppression mechanism triggered by COVID-19 the respiratory system is left vulnerable to bacterial, fungal, and other viral infections. A study of 98 COVID-19 survivors found that 77.2% of patients developed pneumonia, with the most common group of bacteria being enterobacteria (Jakubec et al., 2022).

Interstitial lung disease (ILD) is the most common non-infective pulmonary complication reported after COVID-19 (Jakubec et al., 2022). ILD is a group of diseases that cause pulmonary fibrosis, which is characterized by abnormal repair of lung injury. Lung injury is a common feature of COVID-19 that can persist after the disease and impair pulmonary function (Atabati1, Dehghani-Samani and Gholamreza, 2020). A study of 51 patients found that 47.2% had impaired pulmonary function after COVID-19, with 29.4% having reduced carbon monoxide diffusing capacity (DLCO) (Strumiliene et al., 2021). Reduced DLCO is commonly associated with dyspnea, pulmonary embolisms, and pulmonary fibrosis (de Graaf et al., 2021). A small subset of patients can develop acute respiratory distress syndrome (ARDS) following COVID-19 which can lead to multi-organ dysfunction and death (Gibson, Qin and Puah, 2020). Overall, severity of COVID-19 shows association with these post-disease pulmonary complications (Ahmed et al., 2021).

Cardiovascular Complications

Research has shown that patients present a broad range of cardiovascular manifestations following COVID-19, ranging from mild symptoms like chest pain to major cardiovascular adverse events like heart failure. A study done with 95 570 patients reveals that an adverse cardiovascular event like myocardial infarction, heart failure, stroke, and arrhythmia is seen in 4.8% of patients after COVID-19 (Ayoubkhani et al., 2021). These findings are somewhat consistent with another study where 2.8% of patients presented with stroke, 1.4% presented myocarditis and 0.3% presented arrhythmia (Kamal et al., 2020). Other studies using cardiac magnetic resonance (CMR) have also found higher rates of adverse cardiovascular events (Huang et al., 2020, Ng et al., 2020). Thromboembolisms can be identified as another adverse cardiovascular complication after COVID-19. In a meta-analysis of 8271 patients, 21% of the patients were found to have venous thromboembolism, 20% had deep vein thrombosis, and 2% had arterial thromboembolism (Malas et al., 2020). Research has discovered that the risk of venous thromboembolism is considerably increased following COVID-19 with a shocking fivefold increase in the risk of deep vein thrombosis (Ho and Pell, 2022).

Most literature suggests that COVID-19 survivors are more likely to experience mild cardiovascular complications than adverse events. A study of 81 COVID-19 survivors found that 19% of patients experienced chest pain and 15% experienced palpitations, while another study of 108 COVID-19 survivors found chest pain and palpitations in 25.9% and 22.2% of patients respectively (De Graaf et al., 2021, Santis et al., 2020). Overall, these findings suggest that COVID-19 survivors have a higher risk of cardiovascular complications compared to controls (Ramadan et al., 2021).

Gastrointestinal Complications

The gastrointestinal system can also be affected by post-COVID-19 complications. Studies have found varying rates of general gastrointestinal complications in COVID-19 survivors. A study done with 1783 COVID-19 survivors reveals that 10% of patients had diarrhea, 11% had constipation, 16% had heartburn, 7% had nausea and/ or vomiting, and 9% had abdominal pain (Meringer and Mehandru, 2022). The severity of COVID-19 during hospitalization does not appear to be associated with post-disease gastrointestinal complications, but rather with poor blood oxygen saturation, which is closely related to COVID-19 (Weng et al., 2021).

Liver injury can occur in patients during COVID-19, and some patients may continue to experience symptoms of liver damage after recovery. Studies have found elevated levels of liver injury biomarkers and higher fibrosis scores in patients after COVID-19 (Radzina et al., 2021). One study that periodically analyzed liver biomarkers in 461 patients found that at least one elevated liver biomarker was present in 28.4% of patients at admission, in 25.1% at 1 month, in 13.2% at 3 months, in 16.7% at 6 months, and in 13.2% at 12 months (Liao et al., 2022). Liver injury appears to be associated with the severity of COVID-19 (Fierro, 2020). Metabolic associated fatty liver disease (MAFLD) can be considered a rather serious post-COVID-19 gastrointestinal complication. A study of 235 patients screened for MAFLD 143 days after COVID-19 found that 55.3% of patients were diagnosed with the condition, which is more than double the prevalence seen in the general population (Milic et al., 2022). Interestingly enough, patients with pre-existing MAFLD may be at a higher risk of developing severe COVID-19 once infected (Dongiovanni et al., 2020).

Renal Complications

COVID-19 survivors seem to experience a range of renal complications. Some studies have found a link between recovered COVID-19 patients and overactive bladder (OAB) symptoms related to COVID-19-associated cystitis (CAC). Cystitis is a urinary tract infection that affects the bladder. In one study of 350 patients, 71% reported new urinary symptoms, and 29% reported worsening of existing OAB symptoms (Lamb et al., 2021). Another study found CAC patients with a notable frequency of urinary episodes and nocturia (Lamb et al., 2020). Both of these studies showed an association between CAC and the severity of COVID-19 experienced.

A cohort study done with 1,726,683 US veterans analyzes the risks of eGFR decline, acute kidney injury (AKI), major adverse kidney events (MAKE), and end-stage kidney disease (ESKD) following COVID-19. The results show significant association with the severity of

COVID-19. Non-hospitalized individuals had a 9% increased risk of eGFR decline, while hospitalized patients not admitted to ICUs had a 2-fold increase and those admitted to ICUs had a 3-fold increase. The risk of AKI, MAKE, and ESKD in non-hospitalized individuals was increased by 30%, 50%, and 215%, respectively, while in ICU patients it was increased by 8-fold, 7-fold, and a shocking 13-fold, respectively, compared to controls (Bowe et al., 2021). A comparative study found that eGFR declined 11.3 mL/min/1.73 m² per year faster in patients with COVID-19-associated AKI compared to those with non-COVID-associated AKI (Nugent et al., 2021). Moreover, Cardiovascular complications of COVID-19 may delay recovery from AKI (Yende and Parikh, 2021).

Neuropsychiatric Complications

COVID-19 survivors may experience various psychiatric complications, including post-traumatic stress disorder (PTSD), anxiety, depression, and obsessive-compulsive disorder. One study found that 28% of COVID-19 survivors had PTSD, 42% had anxiety, 31% had depression, and 20% had obsessive-compulsive disorder (Mazza et al., 2020). Other studies have found similar rates of psychiatric complications in COVID-19 survivors, with stress, anxiety, and depression being the most common (Cai et al., 2020, Bareeqa et al., 2020). These psychiatric outcomes seem to be independent of the COVID-19 severity experienced (de Graaf et al., 2021). The exact cause of these complications is not yet fully understood, but it is believed that the disease itself and lifestyle changes due to quarantine or self-isolation may play a role (Silva Andrade et al., 2021).

Neurological manifestations have also been observed in COVID-19 survivors. An analysis of 214 patients has found that 24.8% presented central nervous system (CNS) related and 8.9% presented peripheral nervous system related manifestations. These include olfactory and gustatory dysfunction, spasms, convulsions, cognitive impairment, stroke, headache, and hemorrhage (Silva Andrade et al., 2021). Studies have found a range of prevalence for olfactory and gustatory dysfunction, with some reporting high levels and others lower levels (Lechien et al., 2020, Santis et al., 2020). Cognitive defects, including difficulty concentrating and loss of memory, have also been reported (Peterson, Sarangi and Bangash, 2021, Santis et al., 2020). Guillain-Barre syndrome (GBS), a demyelinating autoimmune disease, has been observed in some COVID-19 survivors, and stroke has been seen to a lesser extent (Ahmed et al., 2022, Kamal et al., 2020). Studies suggest that post-COVID-19 neurological complications may be more common in individuals who were hospitalized for COVID-19 (Nuzzo et al., 2021).

Conclusion

Studies have shown that some patients continue to show symptoms and, in some cases, develop new conditions after recovering from COVID-19. These post-COVID-19 complications can be classified under respiratory complications, cardiovascular complications, gastrointestinal complications, renal complications, and neuropsychiatric complications. In most cases, the severity of these post-disease complications shows association with the severity of COVID-19 amidst some exceptions. Some of the studies done to identify post-COVID-19 complications contain a small sample size and/or do not

completely account for many variables like comorbidities, severity of disease, effect of vaccines, effect of medications, age, sex, ethnicity, geographical location and so on, which suggests there's a fair risk of bias. Nevertheless, the presence of these complications which are inexplicable by any other diagnosis indicates that these complications are in fact long-term consequences of COVID-19. Post-COVID-19 complications remain a highly relevant topic and much is yet to be discovered. Further long-term periodical studies accounting for all variables should be done in order to properly and fully understand the scope of post-COVID-19 complications.

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THE SIDE EFFECTS OF COVID-19 VACCINATIONS AMONG THE PEOPLE AFTER FIRST, SECOND, AND THIRD DOSES

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Abstract

Covid-19 pandemic enforced people to get vaccinated by simple types of vaccines, which were approved in a short period of time. Several side effects were noticed after the vaccination. The data was collected from 83 respondents using an online questionnaire and the questionnaire was validated by initially distributing among 30 individuals. The results have shown that the people who completed mRNA doses vaccination at least two (2) tend to have various side effects. This was confirmed statistically by using IBM SPSS statistics (29) implementing Pearson correlation analysis and independent t-test analysis. The correlation between mRNA vaccines and side effects showed moderately positive and statistically significant relationship ($r = 0.488$, $p < 0.001$) (significant value is 0.05). The t-test proved there is a significant difference for side effects with other vaccines and mRNA vaccines. Hence, this pilot study shows that some health issues have disclosed after the mRNA vaccination. Further, study is needed to ensure the connection between these side effects in accordance with other pre-existed health conditions.

Key words : Covid-19, mRNA vaccines, SARS-CoV-2, Side effects, Vaccine doses.

Introduction

The huge outbreak in the last two years for the world is Covid-19, which is a severe acute respiratory syndrome coronavirus 2. The WHO estimated a cumulative total of 8098 probable SARS cases and 774 deaths around the world in 2002, in a geographic area spanning 29 countries. The illness first appeared in the Guangdong province of southern China, where it persisted for more than 100 days. People have been identified with seven different kinds of variance, including those that caused the SARS, MERS, and Covid-19 epidemics. (Cui et al., 2019) The coronavirus is a family of viruses which usually cause a mild cold. In China, the first Covid-19 case was noticed in December 2019. In March 2020 World Health Organization (WHO) designated the novel coronavirus to be a pandemic disease, indicating that the new virus is spreading quickly around the world (Singh et al., 2020). This led to the pandemic spread rate which was very high, in between 31st December 2019 to 25th of March 2020 more than 414179 infections were confirmed in 197 countries (Baloch et al., 2019). On January 11, 2020, the genetic makeup of SARS-CoV-2 which causes the coronavirus was published. This sparked a surge in global efforts to create a vaccine to prevent the illness and its spreading rate (Le et al., 2020). These viruses are globular and covered in protein spikes. The virus can connect and infect healthy cells with the aid of these spikes. The immune system can identify the same spikes, though bits of the spike could be used in a coronavirus vaccine to stimulate the body's production of antibodies against this new virus (Astuti et al., 2020). In the vaccine development virus-like particles, viral vectors (non-replicating and replicating), peptides, nucleic acid (RNA and DNA), live attenuated virus, inactivated virus and recombinant protein are accessed. Some of them are not the basis for licensed vaccines.

Remarkably, so many vaccine candidates have developed quickly in such a short period, considering that the typical process takes 8 to 15 years (Rai et al., 2020). Clinical trials are being conducted on four different types of vaccines: whole virus, protein subunit, nucleic acid, and viral vector (Geall et al., 2013). A small number of vaccines include injecting the body with antigen (the entire virus and all its protein subunits), whereas other vaccines use viral nucleic acids and protein subunits to activate the immune system and create the antigen. The first Covid-19 candidate entered the human clinical test on 16th March 2020 (Le et al., 2020). Covid-19 mRNA vaccine, created by New York-based Pfizer and the German firm BioNTech, is the first completely evaluated vaccine to be authorized by US Food and Drug Administration (FDA) for use in emergencies in November 2020 (Rai et al., 2020). Another vaccination (mRNA-1273) produced by the Boston-based Moderna business was also given FDA approval for emergency use in December 2020. The Moderna vaccine is also mRNA-based, just like Pfizer and BioNTech. (Rai et al., 2021). During the pandemic, the government, and health sectors enforced people to get vaccinated. There were several side effects noticed by vaccinated people. Some of the effects are back pain, loss of energy, tiredness, discomfort, hip pain, headache, laziness, etc. a report says after the mRNA 2nd dose vaccination 60% of the recipient report a combination of fever, headache, myalgia, and general malaise as their main symptoms (Sprent et al., 2021).

Materials and methods

The quantitative research method has used to gather information which was an online questionnaire. The google form was created for that and distributed to the general public in Sri Lanka. The questionnaire includes demographic data, type of vaccination for each dose, how many doses they injected, do they have allergies, genetic issues and the changes, side effects or illness after the vaccination. The pilot done by 83 individuals and 10 of them were excluded for the unclear and incomplete responses. The categorical data were converted into numerical indices for analysis. The values analysed using IBM SPSS Statistics (version 29) tool.

The hypothesis 1 says there is a significant relationship between people who injected mRNA vaccines for three doses or at least two doses and side effects for vaccination.

The hypothesis 2 says there is a significant relationship between people who inject third Covid-19 vaccine dose and people who have allergies for food and medications.

The hypothesis 3 says there is a significant relationship between people who have allergies for food and some medications and the side effects after the vaccination.

The hypothesis 4 says there is a significant difference in side effects for Covid-19 vaccines between other vaccines and mRNA vaccines.

To prove the hypotheses 1,2,3 the Pearson correlation has been used. To prove hypothesis 4 t-test has been used.

Results and Discussion

The responses obtained were 83 and 10 inappropriate responses were excluded. The study was done with 73 responses. The participations were between 20 to 50 years age group. 34.24% of them were females and 65.75% were males. In the results there was not any

significant correlation between genders. 6.84% of them were infected with covid-19, 68.49% of them were not infected, and 27.39% of them were unsure whether they were infected or not.

Table 1: Type of vaccine and the doses vaccinated among the candidates of the questionnaire.

	Sinopharm	Moderna	Pfizer	AstraZeneca	Sinovac	Covishield	Not taken
1 st Dose	25	19	15	9	-	-	3
2 nd Dose	17	17	13	9	1	-	16
3 rd Dose	3	13	14	1	-	1	41

The Pearson product correlation of people who had mRNA vaccines for at least two doses and side effects for vaccination was found to be moderately positive and statistically significant ($r = 0.488$, $p < .001$) (significant value is 0.01). Hence, hypothesis1 was proven. This shows that the people who were vaccinated with two or more mRNA vaccines are facing side effects such as back pain, loss of energy, tiredness, discomfort, hip pain, headache, laziness after the vaccination.

The Pearson product correlation of third Covid-19 Vaccine dose and people who have allergies for food and medications was found to be low positive and statistically significant ($r = 0.316$, $p = .007$) (significant value is 0.01). Hence, hypothesis2 was proven. This shows that who have allergies for food and medications had some sickness for third dose which was a booster shot.

The Pearson product correlation of people who have allergies for food and some medications and the side effects after the vaccination was found to be low positive and statistically significant ($r = 0.319$, $p < .006$) (significant value is 0.01). Hence, hypothesis3 was proven. This shows that the people who have allergies for food and medications had some side effects after the vaccination.

The Pearson product correlation for age (between 20 to 50 years age group) and side effects were found to be low positive and statistically significant ($r = 0.303$, $P = 0.005$) (significant value is 0.01). and for the Pearson correlation between genetic issues and side effects were found to be negligible and statistically not significant ($r = 0.127$, $P = 0.286$) (significant value is 0.01).

The independent-sample T-test was conducted to compare the side effects for other vaccines and mRNA vaccines. There were significant differences ($t(70) = -4.583$, $p < 0.001$) in the scores with mean score for other vaccines ($M = 0.11$, $SD = 0.318$) was higher/lower than and mRNA vaccines ($M = 0.56$, $SD = 0.506$). The magnitude of the difference in the means (mean difference = -0.444) was significant. Hence, Hypothesis 4 was proven.

Conclusion

This study needs to be elaborated further with higher number of candidates to come into a border conclusion. As per the data collected through this pilot scale study, the mRNA vaccines such as Moderna and Pfizer cause more side effects compare to other vaccines. Also, the people with allergies have some sickness for all type of vaccines and the third booster shots also has a significant impact on people who have allergies. Genetic issues did not show any side effect for Covid-19 vaccines.

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NIPAH VIRUS (NiV) - AN EMERGING BAT-BORNE PATHOGEN

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Abstract

Several emerging and re-emerging viral and zoonotic outbreaks have been on the rise in recent decades. Nipah virus (NiV) is one such emerging pathogen that is likely to cause severe outbreaks in the near future and has been listed as an epidemic threat requiring urgent R&D action by the World Health Organization (WHO). Since it was first detected in Malaysia in 1999, it has caused a number of encephalitis outbreaks across south and south-east Asia, with the most recent one being in the Kozhikode region of Kerala state, India, where it fatally infected a 12-year-old child in late 2021. It is essential to raise awareness and improve the public understanding of (NiV) to control possible outbreaks of this disease. This review outlines the structure, genome organization, epidemiology, mechanisms of transmission, clinical manifestations, diagnosis and treatment of (NiV) disease, and the precautionary measures to contain and ensure a lower incidence in the future.

Keywords : Clinical manifestations, Encephalitis, Emerging infectious diseases (EIDs), Epidemiology, Nipah virus (NiV),

Introduction

The appearance of new infections is inevitable. Emerging infectious diseases (EIDs) are defined as infectious diseases that are newly recognized in a population or have existed but are rapidly increasing in incidence or geographic range. EIDs are a significant burden on global economies and are a serious threat to public health and are often difficult to predict, let alone manage. Controlling these outbreaks requires an understanding of the factors causing them, decreasing fatalities by early discovery, and putting preventative measures in place (McArthur, 2019).

In this context, NiV represents yet another recently emerging zoonotic paramyxovirus endemic to south-east Asia and the western Pacific regions. It is known to be transmitted by its primary reservoir of fruit bats, through intermediate animal vectors, and by human-to-human transmission. The infection causes a great spectrum of diseases from mild to life-threatening encephalitis or fatal respiratory illness in humans and animals. Although Bangladesh is currently the only country regularly reporting human cases, outbreaks have occurred in Malaysia, Singapore, Philippines, and India, with the most recent in the Kozhikode district of Kerala state, India in late 2021 (Alam, 2022).

In 2015, WHO published a list of the top ten emerging pathogens that are likely to cause severe outbreaks in the near future and for which there are few or no medical countermeasures. NiV is included in that initial list of disease priorities that require immediate R&D attention along with Crimean Congo hemorrhagic fever, Ebola virus disease and Marburg, Lassa fever, MERS and SARS coronavirus diseases, and Rift Valley fever (WHO, 2015).

The initial outbreak of NiV occurred in Malaysia and Singapore (NiV-MY strain) in 1998–1999, where 265 human cases of encephalitis were recorded, resulting in 105 deaths. The

spillover of the virus from flying foxes into farmed pigs facilitated the transmission to humans in pig farms. The second strain of NiV emerged in Bangladesh and India in 2001 (NiV-BD), infecting humans without the requirement of pigs to act as an intermediate host. NiV-BD is acquired through ingestion of contaminated date palm sap and >50% of cases resulted from person-to-person transmission (Donnelly, et al., 2020).

A wide spectrum of clinical manifestations ranging from milder symptoms of fever, headache, and drowsiness, to a severe, fatal acute encephalitic syndrome has been reported with distinctive clinical signs such as areflexia, hypotonia, abnormal pupillary response, tachycardia, hypertension, abnormal doll's-eye reflex, and segmental myoclonus, suggesting an involvement of the brain-stem and upper cervical cord (Wong, et al., 2002).

Currently, there is no antiviral drug available for NiV disease, and the treatment is supportive. Ribavirin has been used in a few patients but its efficacy for NiV disease has not yet been determined. (Chua et al., 2000) (Epstein et al., 2006a), as a cited in (Presti et al., 2016)

In the absence of a vaccine, the only way to reduce the risk of infection in people is by raising awareness of the risk factors and educating people about the measures they can take to reduce exposure to the virus.

The purpose of this literature review is to provide background information about the structure and genome organization of NiV, epidemiological patterns up to date and the current knowledge on the possible mechanisms of transmission, clinical manifestations, diagnosis and treatment of NiV disease, and the precautionary measures to contain and ensure a lower incidence in the future.

Methodology

For the purpose of this review, a systematic review of the available literature was conducted using several databases and search engines. Numerous articles were referred from which a total of 30 articles were selected and evaluated for inclusion based on their relevance and the quality of their methods and findings. The articles were then organized and analyzed according to their focus on the NiV virus and the infection, from the results of which this review was developed.

Discussion

Nipah Virus (NiV) structure and genome organization

NiV is a member of the family Paramyxoviridae, subfamily Paramyxovirinae, and genus Henipavirus featuring pleomorphic virus particles with non-segmented, negative-stranded (NNS) RNA genomes consisting of helical nucleocapsids encased in an envelope. Although NiV virions are morphologically similar to those of the other Paramyxoviridae members, peculiar cytoplasmic rings that resembled reticular inclusions were found close to the endoplasmic reticulum membranes in NiV. (Bellini et al., 1998) (Goldsmith et al., 2003) NiV virions were on average larger in diameter (500 nm) than typical paramyxoviruses (150–400 nm), with extreme variations in size (180–1900 nm).

The RNA genome, from the 3'-5', contains a consecutive arrangement of six genes, viz., nucleocapsid (N), phosphoprotein (P), matrix (M), fusion glycoprotein (F), attachment glycoprotein (G) and long polymerase (L). The N, P, and L are attached to the viral RNA forming the virus ribonucleoprotein (vRNP). F and G proteins are responsible for cellular attachment of the virion and subsequent host cell entry (Ternhag and Penttinen 2005; Ciancanelli and Basler 2006; Bossart et al. 2007) as cited in (Singh, et al., 2019).

NiV does not possess the hemagglutinin and neuraminidase properties as commonly observed in many Paramyxoviruses. (Tamin et al., 2002), (Harcourt et al., 2000), as a cited in (Kulkarni et al., 2013).

Epidemiology

Only Pteropid fruit bats of the suborder Megachiroptera, family Pteropodidae, have been identified as natural reservoir hosts of Henipa viruses (Ksiazeka, 2011). There are about 60 different species of these flying foxes, which are found in Asia, China, Australia, and some parts of Africa as well as the Pacific Islands (Koopman, 1992). NiV is contagious, highly virulent, and capable of infecting a wide range of mammalian species in nature (Sharma, et al., 2019).

The outbreak in Malaysia was primarily associated with direct contact with NiV-infected pigs and their products (Sharma, et al., 2019). In the Malaysian NiV outbreak human to human transmission was found to be rare (Mounts et al., 2001).

In the Bangladesh outbreak, virus transmission occurred directly from bats to humans without the involvement of intermediate animal hosts, and human-to-human transmission is occurring with some regularity; this may also be the case in India (Chadha et al., 2006; Gurley et al., 2007; Hsu et al., 2004; Luby et al., 2006). Field investigations have also indicated that drinking contaminated fresh date palm sap is significantly associated with NiV infection (Luby et al., 2006).

The epidemiology related to NiV has not been fully understood as a Biosafety level-4 (BSL-4) laboratory facility is required for virus research.

Mechanisms of transmission of the Nipah virus

The introduction of NiV infection into the human population occurs mainly by two mechanisms of spillover from flying foxes: transmission via an intermediate animal host, which triggered the outbreak in Malaysia; and bat-to-human transmission, which occurred in Bangladesh and India.

In Malaysia, occupations involving close contact with and handling of pigs were associated with the highest risk of human NiV infection, and transmission to people is assumed to have happened by direct contact with infectious secretions or excretions of pigs. Only a small number of infected people had no history of contact with or proximity to pigs, and human-to-human transmission is suspected in a few cases (Sharma, et al., 2018).

In Bangladesh, ingestion of fresh date palm sap is the most commonly implicated route. The second route of transmission is via domestic animals. Third, direct contact with NiV-infected bat secretions (Hughes, et al., 2009).

The most likely mechanism of person-to-person transmission is the passage of respiratory secretions contaminated with NiV from a patient to the respiratory tract of an uninfected person following physical contact (Luby, 2013). A number of cases of human infection in Bangladesh were also attributed to corpse-to-human transmission (Clayton, 2017).

Nipah Virus Infection – clinical manifestation, diagnosis, and treatment & prevention

In humans, NiV infection induces an encephalitic illness characterized by headaches, pyrexia, and other neurological symptoms. In the majority of patients, fever was found to be the most common symptom, followed by headache. Other symptoms included vomiting, disorientation, brain stem anomalies, reduced or absent reflexes, and doll's eye reflexes. After neurological symptoms, the most common respiratory symptoms are cough, cold, and dyspnea. Respiratory and atypical chest symptoms were more common in Bangladesh than in Malaysia. (Sharma, et al., 2018). In pigs, NiV infection induces a febrile respiratory disease characterized by a severe cough (Kulkarni, et al., 2013).

NiV is detected via molecular and serological tests, immunohistochemistry, histopathology, viral isolation, and neutralization. PCR is the most extensively used and sensitive diagnostic technique (Pillai, et al., 2020).

There are currently no specific antivirals or antibodies available to combat the illness. Although two medications, ribavirin, and chloroquine, have been found, their therapeutic efficacy has yet to be shown. Ribavirin, on the other hand, has been shown in vitro to be effective against NiV replication. In preclinical studies, monoclonal antibodies have been used for treatment purposes (Singh, et al., 2019).

Activities that involved direct contact with pigs were linked with the highest risk of infection; however, not all case patients reported such exposures, and other animals may have been the source of some infections. The fact that the outbreak stopped after the culling of pigs in the outbreak-affected areas suggests that, even if other sources of infection exist, they are secondary to the presence of infected pigs and that pigs are required to sustain transmission. Efforts to prevent and control outbreaks of this new zoonotic infection should focus on preventing infection in pigs and restricting human contact with infected animals (Parashar, et al., 2000).

Drinking fresh date palm sap was the most highly related risk factor among the exposures evaluated for this epidemic of human NiV infection (Rahman, et al., 2012). The outbreak terminated after the government of Bangladesh issued a local warning against drinking fresh date palm sap. As a result, it is recommended that date palm sap not be consumed fresh unless appropriate measures have been made to prevent bat access to the sap during harvesting.

Conclusion

Several emerging and re-emerging viral and zoonotic outbreaks have been on the rise in recent decades. Such outbreaks serve as a cautionary tale that should be used to improve disease monitoring and surveillance efforts in order to prevent future outbreaks. NiV is a bat-borne paramyxovirus that causes a lethal neurologic and/or respiratory disease in humans and domestic animals. It is an important threat owing to its broad host and geographical range,

high case fatality, the potential for human-to-human transmission, and lack of effective prevention or therapies. As an RNA virus, NiV has an exceptionally high rate of mutation. If a human-adapted strain were to infect South Asian communities, the region's high population densities and global interconnectedness would cause the infection to spread quickly. Humans are already susceptible to NiV. Many strains are capable of limited person-to-person transmission. These factors raise the likelihood of NiV becoming a global pandemic. The key to controlling the outbreak and reducing mortalities is early detection of the outbreak and installing preventive measures. Until we better understand the basics of NiV, our ability to prevent spillovers and cure the disease will not improve. Future priorities should include continuing to monitor and investigate NiV infection outbreaks, identifying and assessing methods to stop NiV transmission, and enhancing clinical case management in locations with limited resources.

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AWARENESS OF SRI LANKAN COMMUNITY ON DRUG ABUSE

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Abstract

According to the Global Study on trends and estimates on number of people who use drugs in 2020; millions of people have used cannabis, opioids, amphetamines, cocaine, and ecstasy, exhibiting a significant issue of drug abuse on a global scale, even with escalating usage of cannabis, heroin, cocaine, and methamphetamine in countries such as Sri Lanka where this increase has influenced drug abusers to shift in to more dangerous narcotics such as heroin. The goal of this study was to bring attention to this problem to promote awareness and prevent drug abuse in Sri Lanka. This research entailed a mixed qualitative and quantitative cross-sectional study to collect primary data. The qualitative study mainly provided insight into reasons influencing drug abuse and shortcomings to be solved to reinforce prevention of drug abuse, whereas the quantitative study indicated the age bracket of overall awareness with the lowest at 12-18, and the greatest within 30-49. According to the awareness scores, Sri Lankan community showed the lowest awareness of the legal aspect while below average awareness of knowledge on overcoming methods and withdrawal. Collectively, individual and societal awareness focused primarily on adolescents would contribute to the effective prevention and management of drug abuse.

Keywords : Awareness, Drug abuse, Illicit, Prevention, Sri Lanka

Introduction

Within the last decade, drug abuse has developed into a serious problem, which negatively affect the drug abused victims, their families, and the community, increasing drug usage in an alarming rate. The most widely abused drugs in Sri Lanka are Cannabis, Heroin, Cocaine and Methamphetamine (NDCCB, 2021). According to studies, Heroin has become the illicit narcotic to catch on in popularity after cannabis.

With the emergence of various types of illicit drugs, a significant burden on the world has been noticed recently, leading to several detrimental consequences like impaired coordination and performance, anxiety, suicidal tendency, and psychotic symptoms (Karila et al., 2014).

According to the Global estimates on the prevalence of drug abuse in 2020, cannabis, opioids, amphetamine, cocaine, and ecstasy were used by 209, 61, 34, 21, 20 million people ranging from 15-64 years respectively. Despite the fact that cannabis is the most commonly used drug in the world, opioid products are the most frequently used drug in South Asian countries (Bremond, 2022).

The prevalence of illicit drug abuse in Sri Lanka which is underestimated is stigmatizing. The recent drug-related arrests in Sri Lanka show that heroin users account for 46% of all arrests, with cannabis, methamphetamine, and cocaine accounting for 30%, 12%, and 0.01%,

respectively (Drug related statistics, 2021). According to 2021 statistics, there has been a significant shift from cannabis to heroin in the years of 2019-2020. Therefore, this trend could be an indication of Sri Lankan drug users moving to more harmful drugs like, heroin. Thus, the prevention becomes an extremely important factor (NDDCB, 2021). Therefore, the goal of this study was to bring this case into light and acknowledge the Sri Lankan community regarding the problems of drug abused victims, the statistics on substance addiction, method of rehabilitating the victims, and to raise awareness and prevention of drug abuse.

Methodology

A mixed qualitative and quantitative cross-sectional study was designed to collect primary data. Qualitative questionnaires were designed to get expert opinions on legal, educational and health sectors. Thus, interviews, documentations and observations were carried out for further study. To analyze the awareness of the Sri Lankan community on drug abuse, a quantitative questionnaire was designed as a Google form and was distributed through social media platforms to schools, universities, and etc. This survey was prepared in English, Sinhala and Tamil to reduce literacy barriers. The questionnaire was structured into several sections to address various aspects of awareness with a total number of 24 questions. The response type was designed according to Likert scale. Five options were given, numerical values were assigned to each option as follows: 1 = very unfamiliar, 2 = unfamiliar, 3 = neutral, 4 = familiar, and 5 = very familiar. Responses were collected for 5 days, and 1,012 responses were received. MS Excel and IBM statistics SPSS were used to analyze the collected data. Depending on the numerical values assigned for each option an overall and sector wise mean output of awareness was obtained which was considered as an awareness score. The variations of these awareness scores with demographic data were further analyzed.

Results & Discussion

The result of the qualitative study showed that heroin, ice and cocaine were abundantly used by the general public. A prevalence of thool and over-the counter drugs was seen among school students. As a common opinion of the police and the rehabilitation center, drug abuse was profusely seen within the age group of, 18-35. An emerging threat was noticed among school students above the age of 12. Common reasons influencing drug abuse were identified to be; curiosity, negligence, peer pressure, family and mental health issues. Interestingly, a considerable increase in drug abuse was observed after Covid-19. This could be a result of reduced awareness and isolation due to lockdown.

According to the awareness score obtained from the quantitative analysis, the lowest awareness was recorded for the legal aspect, whereas the highest awareness was for the social aspect (Table 01). Awareness of all the other aspects is above average apart from awareness of overcoming methods and withdrawal (Table 01). Awareness programs should be designed in such a way that it indicates the severity of the legal consequences and knowledge on overcoming methods and withdrawal. Further, even though prevention policies are included in the Sri Lankan law, accurate implementation is lacking. This should also be rectified in order to minimize this issue.

Table 1- Sector wise awareness (mean = awareness score)

	N	Minimum	Maximum	Mean	Std. Deviation
Average awareness on social consequences (Avg_SC)	1012	1	5	3.77	1.430
Average awareness on health consequences (Avg_HC)	1012	1.00	5.00	3.4318	1.31644
Average awareness on education, professional and financial consequences (Avg_EPF)	1012	1.00	5.00	3.7615	1.19778
Average awareness on legal consequences (Avg_LC)	1012	1.00	5.00	2.9018	1.14813
Average awareness on Identifying drug abusers (Avg_IDA)	1012	1.00	5.00	3.5390	1.23728
Average awareness on overcoming methods and withdrawal from drug abuse consequences (Avg_OMWDA)	1012	1.00	5.00	3.1058	1.08841
Valid N (listwise)	1012				

According to Table 2, the overall awareness with respect to the age was the lowest within the age group of 12-18, whereas it was the highest within the age group of 30-49. A similar pattern was also noticed when considering the sector wise awareness scores.

Table 2- Variation of awareness depending on age (mean = awareness score)

2. Age		Avg_SC	Avg_HC	Avg_EPF	Avg_LC	Avg_IDA	Avg_OM WDA	Overall_A wa
12 - 18	Mean	3.26	2.9725	3.0568	2.3425	2.8379	2.4235	2.8162
	N	182	182	182	182	182	182	182
	Std. Deviation	1.511	1.33742	1.32727	1.17077	1.37854	1.11964	1.09831
18 - 29	Mean	3.79	3.4635	3.8210	2.9403	3.5829	3.1767	3.4628
	N	525	525	525	525	525	525	525
	Std. Deviation	1.410	1.28316	1.10847	1.08122	1.11986	.99335	.91124
30 - 49	Mean	4.08	3.7271	4.0997	3.2141	3.9828	3.4792	3.7644
	N	204	204	204	204	204	204	204
	Std. Deviation	1.385	1.29381	1.14584	1.16011	1.19149	1.07272	.97180
50 and above	Mean	3.96	3.4983	4.0396	3.0792	3.6782	3.2129	3.5781
	N	101	101	101	101	101	101	101
	Std. Deviation	1.232	1.29840	.98915	1.08643	1.12157	1.01574	.90815

Depending on these results we can deduce that adolescents face an immediate threat of drug abuse due to the lack of awareness. Effective drug education is therefore essential for youngsters because they are more susceptible to an immediate threat than other age groups. Prevention can also aid in the development of a prescriptive culture of safety, moderation, and informed decision making (Vic.gov.au, 2019)

Awareness should therefore be stressed at the school level, by implementing various awareness programs and inclusion in the curriculum. Addressing this issue would get us a step closer towards prevention.

Conclusion

This study has primarily provided insights into successful methods of prevention through raising public awareness. Initially, a thorough literature review was carried out followed by the collection of qualitative data with the assistance of specialists from the legal, educational, and health sectors. Thereafter, an analysis was conducted using a quantitative questionnaire. As a result, we could conclude that relative modifications in the current law on drug misuse

should be implemented and emphasized among the public immediately. Finally, it can be claimed that effective awareness of identification, management, and safeguarding a victim via rehabilitation can aid in minimizing the harm posed by drug usage.

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AN OVERVIEW OF ANTIMICROBIAL AND ANTI-CANCER POTENTIAL OF *CANNABIS SATIVA*

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Abstract

Cannabis sativa L. is a very diverse plant of the Cannabaceae family contains 9-tetrahydrocannabinol (9-THC) and cannabidiol (CBD), which are important because of their effects on inflammation, antioxidative, anti-inflammatory, neuroprotective, antibiotic and cancer-related pain. To retrieve further information about the plastome of cannabis, CpDNA can be isolated and Chloroplast Genome can be Sequenced. THC and other cannabinoid receptor ligands encourage tumor angiogenesis suppression, cancer cell death, and cancer cell growth inhibition (apoptosis). One of the biggest concerns to public health has been identified by scientists and healthcare officials as the global increase in bacterial resistance against commercial antibiotics. To maintain the life-saving benefits against bacterial infections, novel antibacterial techniques, and antibacterial substances are urgently required to combat the rising prevalence of antibiotic-resistant and, in particular, multidrug-resistant (MDR) pathogens. This study aims to prove that most of the compounds of cannabis are found to be more effective than commercial antibiotics by means of antimicrobial and anti-cancer properties.

Keywords: 9-tetrahydrocannabinol, Cannabidiol, Antimicrobial, Anti-cancer

Introduction

Cannabis sativa L. belongs to the family Cannabaceae and has only one genus (*Cannabis*) followed by one species (*sativa*) and is a highly varied plant. Marijuana is the basic medicine obtained from this plant (Elsahly and Slade, 2005). The chemicals found in medicinal *Cannabis sativa* L., such as 9-tetrahydrocannabinol (9-THC) and cannabidiol (CBD), and their effects on inflammation, antioxidative, anti-inflammatory, neuroprotective, antibiotic, and cancer-related pain have received much interest in recent years (Reginald, 2020, Pellati F., 2018). Female flowers are the primary products of cannabinoids meanwhile male plants do not produce large amounts (Tanney et al., 2021). Phytocannabinoids in *Cannabis* are synthesized in the glandular trichomes.

The term "cannabis" refers to any product derived from the *Cannabis sativa* plant. *Cannabis sativa* plant components or byproducts that have high tetrahydrocannabinol (THC) concentrations are referred to as "marijuana". The psychoactive substance of marijuana that has an impact on a person's mental state is THC.

The ratio of CBD to THC determines whether cannabis plants with a high concentration of cannabidiol (CBD) will be used therapeutically rather than as a psychoactive substance. Several cannabis hybrid cultivars have recently been created to enhance THC or CBD output (Small and Cronquist, 1976, Struik et al., 2000).

One of the biggest concerns to public health has been identified by scientists and healthcare officials as the global increase in bacterial resistance against commercial antibiotics (National Academies of Sciences, 2017). To maintain the life-saving benefits against bacterial

infections, novel antibacterial techniques, and antibacterial substances are urgently required to combat the rising prevalence of antibiotic-resistant and, in particular, multidrug-resistant (MDR) pathogens (Klahn, 2020). These targeted bacterial pathogens are primarily Gram-negative bacteria that are resistant to most available antibiotics. Due to the general structure of the Gram-negative cell envelope, which results in a highly effective permeation barrier and renders the majority of medications with antibacterial activity against Gram-positive pathogens inactive against Gram-negative ones, the development of new antimicrobial drugs against Gram-negative bacteria is particularly difficult (National Academies of Sciences, 2017). The ratio of CBD to THC determines whether cannabis plants with a high concentration of cannabidiol (CBD) will be used therapeutically rather than as a psychoactive substance. Several cannabis hybrid cultivars have recently been created to enhance THC or CBD output (Small E, 1976) (Struik P. C, 2000).

The use of cpDNA in investigations of taxonomic, biogeographic, and evolutionary divergence is made possible by the plastid genome's (plastome) high degree of conservation and the presence of significant differences (Matielo et al., 2019). Plastosomes range from 35,000 to 217,000 base pairs and encode 63 to 209 209 genes, which are in charge of controlling a plant's photosynthetic processes (Matielo et al., 2019). Cloning cpDNA into plasmid vectors, selecting clones containing cpDNA, and sequencing the clones using both plasmid and chloroplast-specific primers, chloroplast genomes have been sequenced. The separation of highly purified cpDNA required for this labor-intensive method can be challenging for many taxa (Jansen et al., 2005). To detect the antibacterial activity of cannabis, *Cannabis sativa* leaf extracts have been used against some selective bacterial strains (Naveed et al., 2014). The *Cannabis Sativa* leaf extracts against gram-positive ATCC (American type cell Culture) bacteria and gram-negative bacteria (Naveed et al., 2014). The Phenyl moiety of cannabinoids in these plant leaf extracts acts as a good antimicrobial agent (Appendino et al., 2008).

Methodology

Extraction of Cannabinoids

The *Cannabis sativa* clusters of the flower (inflorescences) can be used to isolate CBD (Martinenghi et al., 2020) and leaf parts can be used to isolate CBD and THC (Naveed et al., 2014). There are various extraction methods, and some of the popular methods are highlighted in table 01.

Table 01: Extraction methods of medicinal cannabinoid compounds

Method	Basis and Format
Solvent Extraction	Uses solvents such as ethanol, butane, or carbon dioxide to extract oils from the plant material. Solvent extraction is considered a safe and efficient method of producing high-quality cannabis oil (Lazarjani et al., 2021)
Supercritical CO ₂ Extraction	Uses high-pressure CO ₂ to extract the oils from the Cannabis hybrid flowers. This method is considered

	one of the most efficient and safe methods of producing cannabis oil, as it does not use any toxic solvents (Daniel et al., 2018).
Olive Oil Extraction	Uses olive oil as the solvent to extract the oils from the plant material. This method is considered safe, but it may not produce the same quality of oil as the other methods (AL Ubeed et al., 2022)
Steam Distillation	Uses steam to separate the oil from the plant material. This method is considered safe and efficient, but it may not produce the same quality of oil as the other methods (Colin, 2020).

The fatty acids and other unwanted plant materials are removed from the extract and subjected to decarboxylation which results in the desired compounds. This mechanism is known as “winterization”. The distillation process takes place after winterization. The desired compounds such as THC and CBD can be isolated by heating under pressure to the respective temperatures of the cannabinoid’s boiling point. The boiling points of THC and CBD are 157⁰C and 165⁰C respectively. The isolated compounds can be mixed to create different mixtures (Colin, 2020). High-Performance Liquid Chromatography (HPLC) can be used for further analyses (Martinenghi et al., 2020).

Results and Discussion

Antibacterial Effects of Cannabis sativa derived molecules

The antimicrobial activity of constituents of Cannabis sativa has been first demonstrated against *Staphylococcus pyogenes aureus* as the gram-positive bacteria and *Escherichia coli* as the gram-negative bacteria (Krejci, 1950). Various techniques have also been used in *C. sativa* extractions of oils and other materials. Cold pressing and solvent extraction are conventional methods, but novel, higher-yielding technologies that produce better products are already starting to take hold. While ultrasonic-assisted extraction (UAE) methods utilize less solvent and have quick processing times, with higher yields and equal quality, pressurized liquid extraction avoids the need for filtration. Microwave-assisted and supercritical fluid extraction are both "green" methods (Fathordoobady et al., 2019).

The essential oils of five different cultivars of Cannabis sativa against a wide variety of gram-positive and negative pathogens have been evaluated. The antimicrobial activity of these compounds against *Acinetobacter calcoaceticus* and *Brevibacterium linens* was weak. The antimicrobial activity can be seen in Δ 9 –THC, CBD, and CBN very low concentrations were detected) found in all essential oils (Novak et al., 2001). An antimicrobial effect against gram-positive bacteria was detected in the oil extracted from the seeds of the whole plant by petroleum ether and methanol. Nevertheless, any impact of antifungal activity has not been detected (Klingeren and Ham, 1976).

Recent studies have shown that cannabis is used in antibiotic-like activities against highly varied microorganisms (Hong, 2022). The efficacy of cannabis-derived molecules against

Gram-negative bacteria and gram-positive bacteria has been summarized in Tables 02, and 03.

Table 02. Efficacy/inhibition zones of cannabis-derived molecules against Gram-negative bacteria

Cannabis-derived compound	Strain	Targeted bacteria	Efficacy/ inhibition zone	Reference
Cannabidiol (CBD)	ATCC 13762	<i>Escherichia coli</i>	29 µM *	Russo et al., 2021
Essential oils	14 strains, variant Ab sensitivity patterns	<i>Helicobacter pylori</i>	8–64 µg/mL ** 8–64 µg/mL ***	Zengin et al., 2018
Water extract	ATCC 10536	<i>Escherichia coli</i>	7.1 mg/mL **	Ferrante et al., 2019
Cannabinol oil extract	ATCC 9027	<i>Pseudomonas aeruginosa</i>	2% **	Di Onofrio et al., 2019
CBD	ATCC 49226	<i>Neisseria gonorrhoeae</i>	1 µg/mL **	Blaskovich et al., 2021
Aqueous extract (5µg/ml and 10µg/ml)	Not specified	<i>Vibrio cholera</i>	4mm and 8mm respectively.	Lone & Lone, 2012
Acetone extract (5µg/ml and 10µg/ml)	Not specified	<i>Vibrio cholera</i>	5mm and 10mm respectively	Lone & Lone, 2012

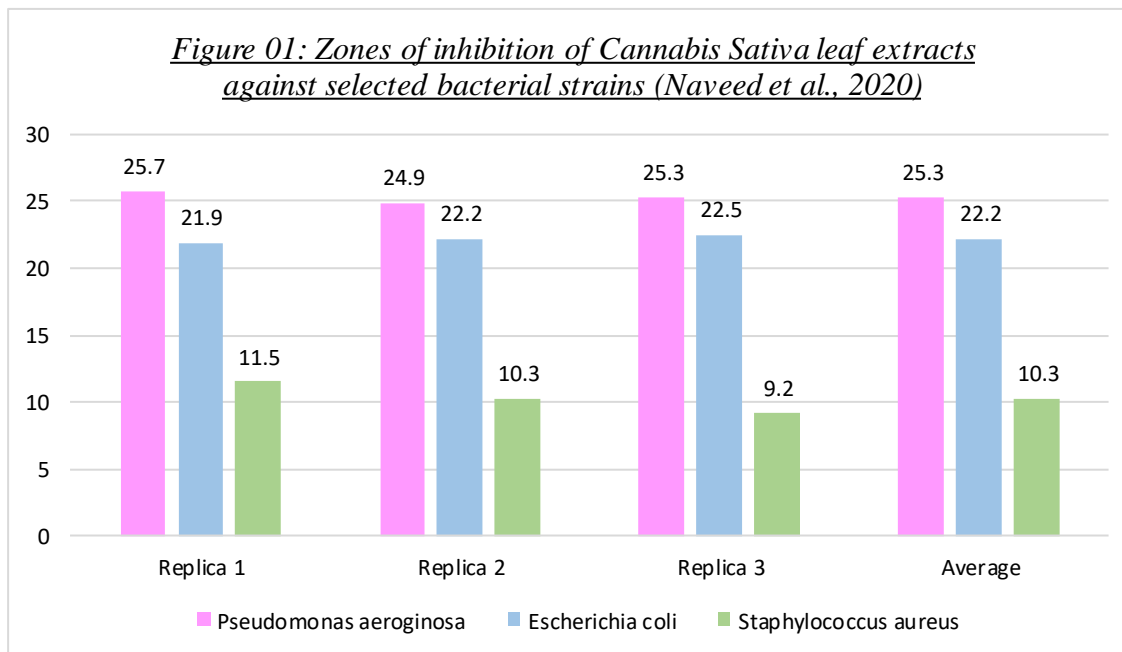
* IC₅₀ (The half maximal inhibitory concentration); ** MIC (Minimum inhibitory concentration); *** MBC (Minimum bactericidal concentration)

Table 03. Efficacy/inhibition zones of cannabis-derived molecules against Gram-positive bacteria

Cannabis-derived compound	Strain	Targeted bacteria	Efficacy/ inhibition zone (mm)	Reference
Essential oils	V5, EQ19	<i>Enterococcus faecium</i>	1–32 µg/mL **	Iseppi et al., 2019
CBD	ATCC 6919	<i>Cutibacterium acnes</i>	1–2 µg/mL **	Blaskovich et al., 2021
CBD	18Bs	<i>Staphylococcus epidermidis</i>	16 µg/mL **	Iseppi et al., 2019
Leave extracts and stem extracts	ATCC 12600	<i>Staphylococcus aureus</i>	25mm inhibition zone (by disc diffusion)	Borchardt et al., 2008

			method)	
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7.1mg/ml of minimum inhibitory concentration has been marked in water extracts against *Escherichia coli* gram-negative bacteria (Ferrante et al.,2019). A wide inhibition zone diameter (25mm) against *S. aureus* has been noted in leaves and stems extracts of *C. sativa*. The disc diffusion method has been used in this process (Borchardt et al,2008).



A recent study showed that the leaf extracts of *Cannabis Sativa* was found to have strong antibacterial properties. The study measured the ability of the leaf extraction to inhibit the growth of various strains of bacteria, and found that it was effective against *Staphylococcus aureus*, *Pseudomonas aeruginosa*, and *Escherichia coli* with inhibitory diameters of 10.3 mm, 25.3 mm, and 22.2 mm respectively (Naveed et al., 2020).

Antimicrobial activity has been tested by ethanolic, petroleum ether, crude extracts of the leaves, and isolated acidic fractions of *Cannabis sativa*. Though aqueous extracts failed to show any activity against gram-positive and gram-negative bacteria, petroleum ether and ethanolic extracts followed by isolated acidic fractions showed antimicrobial activity against gram-positive, and gram-negative bacteria and fungi (*Candida albicans*) (Schofs et al.,2021).

Anti-cancerous properties of Cannabis sativa-derived molecules

Preclinical studies have shown that cannabinoids produced from plants, such as tetrahydrocannabinol and cannabidiol, have antiproliferative, cytotoxic, and antimetastatic effects. Some studies have suggested that compounds found in cannabis, such as tetrahydrocannabinol (THC) and cannabidiol (CBD), have anti-tumor properties and can help to reduce the growth and spread of certain types of cancers, such as lung cancer, breast cancer, and prostate cancer. The exact mechanisms by which cannabis may exert its anti-cancer effects are not well understood, but some theories suggest that it may work by inducing apoptosis (cell death) in cancer cells, reducing angiogenesis (the formation of new

blood vessels that feed tumors), and limiting the spread of cancer cells through the body (O'Reilly et al., 2022).

The role of Tetrahydrocannabinol (THC) and Cannabidiol (CBD) in cancer

The primary psychoactive substance found in *Cannabis sativa* L. cultivars is 9-tetrahydrocannabinol (THC), which exerts its effects on the central nervous system by activating CB1 receptors. Oral administration of THC is the most popular technique, and because of its high lipophilicity (the tendency of a molecule to mix with an oily state than water), it is strongly coupled to plasma proteins and easily reaches vascularized tissues including the heart, and lungs. There are issues with recommending THC for medical use in cancer patients because of the psychoactive effects of THC that are mediated in the CNS. When prescribing THC to cancer patients for medical purposes, several concerns are raised because of the psychoactive effects of THC that are mediated in the CNS (Afrin et al., 2020). THC at a dosage of 14 μ M suppressed overall cell growth and proliferation in breast cancer cells (Ligresti et al., 2006). In addition, the favorable results of combined therapy with cannabinoids and chemotherapeutic agents were dependent on the sequence of administration; when cannabinoids were administered after chemotherapy, cell apoptosis increased. THC resulted in 13 μ M of IC₅₀ and CBD had an IC₅₀ of 8 μ M in a leukemia model. When specific cannabinoids are mixed, the resulting substance can be used synergistically with popular anti-leukemia medications, allowing the dose of the cytotoxic medicines to be significantly decreased while remaining effective (Scott et al., 2017). THC reduced the IC₅₀ values of proven anti-cancer drugs by almost 50% by sensitizing leukemia cells to these drugs. Lung cancer cell proliferation can be induced by low levels of THC. In vitro and in vivo testing of THC-loaded nanoparticles for the treatment of lung cancer revealed considerable cytotoxicity against human and murine lung cancer cells (Martin et al., 2015). Also, upon the treatment of THC, the cell viability has been reduced in Prostate cancer cells (De Petrocellis et al., 2013).

Apart from THC, Cannabidiol (CBD) also can enhance reactive oxygen species (ROS) production and trigger endoplasmic reticulum stress apoptosis in breast cancer cells (Shrivastava et al., 2011). One of the originally recognized key targets of these emerging anticancer drugs is the epidermal growth factor receptor (EGFR). To activate various signal pathways, such as the MAPK-Erk, PI3K-Akt, and STAT pathways, epidermal growth factor (EGF) may bind to the EGF receptor (EGFR) on cells. These pathways are crucial for cell proliferation and differentiation. Cannabidiol inhibits EGF-induced proliferation followed by migration and invasion of breast cancer (Elbaz et al., 2015). In extremely invasive breast cancer cells, CBD can reverse the EMT (Garcia et al., 2020). Researchers studied the effects of CBD on cancer patients receiving palliative care and discovered that daily CBD doses were often well tolerated, with 50% of patients reporting overall improvements in their health. However, they noticed that these findings need validation in a trial with placebo controls (Good et al., 2019).

Conclusion and Recommendations

Among all plants, *Cannabis sativa* is one of the most versatile plants. People have used it to make fuel, materials, textiles, and cosmetics. The extraction methods can be used to extract oils from *Cannabis sativa* for use in treating cancers, but the quality of the oil will depend on the quality of the plant material, the extraction method used, and the conditions under which the oil is produced. It is important to use high-quality plant material and to follow good manufacturing practices to ensure the safety and efficacy of the extracted oils. Numerous cultures have long used the *Cannabis* plant for medicinal purposes, and also consists of healing properties. THC and CBD can be endogenously produced, artificially, or can be derived from the plant *Cannabis sativa*.

The most fundamental hallmark of cancer is abnormal cell proliferation. THC and other cannabinoid receptor ligands inhibit cancer cell proliferation and promote tumor angiogenesis inhibition and cancer cell death (apoptosis). In cancer animal models, cannabinoids improve the anticancer effects of other antineoplastic drugs. Phase I/II clinical studies are actively testing cannabinoids as anticancer drugs. The therapeutic potential of cannabidiol in the treatment of prostate, myeloma, melanoma, leukemia, cervical, ovarian, and endometrial malignancies has been further investigated. Cannabinoids have been recently shown to exhibit anti-inflammatory and immunosuppressing effects against the COVID-19 immune response. However, further evidence-based clinical studies are needed to determine the efficacy and safe dosage of *Cannabis* extracts for treatment of COVID-19. Pharmacological research coupled with rapidly evolving genome-based biotechnology will further facilitate exploring *Cannabis* plants for tremendous potential in drug-discovery.

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MOLECULAR ANALYSIS OF TAP WATER SAMPLES FROM DIFFERENT PARTS OF THE COUNTRY TO DETECT THE PRESENCE OF BACTERIA

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Abstract

The demand for water in Sri Lanka is gradually rising, mostly due to the growth of the industrial sector and the need for agriculture, but also mainly for drinking. In Sri Lanka, about 43.4% of the population, use piped water, according to the results of the National Water Supply and Drainage Board (NWSDB). The Jaffna Peninsula had the highest incidences of the country's 2588 *Salmonella* positive cases between 2005 and 2013. This is because the findings showed that total coliform and *E. coli* bacteria were present throughout the peninsula and six of the sampling sites that tested positive for *Salmonella* spp. were used for drinking. Drinking water is a significant source of microbial pathogens in developing countries, as poor water quality, sanitation, and hygiene are responsible for approximately 1.7 million deaths worldwide each year, primarily due to infectious diarrhea caused by *Escherichia coli*, *Shigella* spp., and *Campylobacter jejuni*. The study was focused on revealing the presence of bacteria in tap water samples in different parts of the country, and the analysis was performed following the culture method and PCR analysis. The results of the study revealed that Puttlam, Gampaha, and Galle districts water samples were contaminated with bacteria and further molecular analysis only confirmed the presence of *E. coli*.

Key words: Bacteria, DNA extraction, *Escherichia coli*, PCR analysis, Tap water

Introduction

Water is a vital natural resource and a fundamental human necessity for life. Groundwater has become into an issue in recent decades as essential resource because of its abundance and purity (Verma et al., 2013). The demand for water in Sri Lanka is gradually rising, mostly due to the growth of the industrial sector and the need for agriculture. The main climatic divides in Sri Lanka are the dry and wet zones, and most people rely on groundwater for domestic use. Water quality varies by region of the country since the physical and chemical components of water quality are intimately tied to climatic fluctuations. Typically, shallow dug wells in Sri Lanka are used to extract groundwater for drinking (Mahagamage, Chinthaka and Manage, 2014).

Mahagamage et al. (2019) reported in Sri Lanka, 12,823 instances of typhoid fever were reported between 2005 and 2014, while Anuradhapura district was rated as the twentieth district with just 133 cases during that time and results of the investigation of Mahagamage et al. (2019) showed that almost all sampling locations were contaminated with total bacteria and *E. coli*, and the values were not up to Sri Lanka Standards and World Health Organization (WHO) drinking water quality standards. According to Sri Lankan Standards and the Health Ministry regulation in Sri Lanka, the total coliform count should be zero per

100 ml for drinking water (Arulnesan et al., 2015). In about 32% of the sampling sites, *Salmonella* spp. were found. Furthermore, the WHO estimates that around 1.1 billion people worldwide consume contaminated water and the bulk of diarrheal disease worldwide (88%) is caused by contaminated water, inadequate sanitation, and poor hygiene. Unsafe water, sanitation, and hygiene are responsible for around 3.1% of annual deaths (1.7 million) and 3.7% of the annual health expense globally (54.2 million) (Ashbolt, 2004).

Different types of bacteria commonly found in tap water include *Escherichia coli*, *Shigella dysenteriae*, *Salmonella paratyphi*, *Vibrio cholerae*, *Salmonella typhi*, *Shigella flexneri*. Drinking tap water contaminated with *Escherichia coli*, a fecal coliform, can cause intestinal inflammation (Cabral, 2010). Many studies have shown that drinking water contaminated with coliforms including *Escherichia coli*, *Salmonella* spp., and *Vibrio cholerae* can result in major problems such diarrhea, enteritis, and even death, as well as huge financial losses (Momtaz et al., 2013). The most prevalent and widely spread waterborne and foodborne illnesses globally are salmonellosis and shigellosis, which are typically characterized by an acute onset of fever, diarrhea, abdominal pain, nausea, and vomiting (Chalker and Blaser, 1988). This study aims to carry out a molecular analysis to detect the presence of bacteria in tap water samples obtained from different parts of the country. This would help to prevent the spread of serious waterborne diseases caused by bacteria like *Escherichia coli*, *Salmonella*, *Staphylococcus* in tap water samples and will mainly help to build up a healthy society in Sri Lanka.

Methodology

250ml volume of tap water was sampled from five different districts of the country: Puttlam, Gampaha, Colombo, Kalutara, and Galle. The water samples were collected only from drinking tap water lines by removing external tap fittings such as rubber tubes or hose attachments from the tap, and the water samples were collected into the sterile sample bottles in a gentle stream of water (Kalkhajeh et al., 2019). LB (Luria-Bertani) media was made by combining 1g of Tryptone, 0.5g of yeast, 1g of NaCl, and 1.5g of agar in 100 ml of distilled water. Water samples were processed to concentrate the bacteria in each sample and 75µl of processed sample was plated on LB agar. *E. coli* were used for positive control, and distilled water was used for negative control. Plates were incubated at 37°C for 24h. Following 24h, bacterial DNA was extracted from plates which showed growth, using the boiling method. Next, universal bacteria PCR and agarose gel electrophoresis was carried out (Lorenz, 2012). PCR for the identification of *E. coli* alone followed by agarose gel electrophoresis was done in samples showing a positive result.

Results

After the spread plate procedure was completed and all the plates were incubated at 37 °C for 24 hours for the growth of bacteria. Images representing the growth of bacteria colonies from tap water collected from the five districts, after 24 hours is given below.

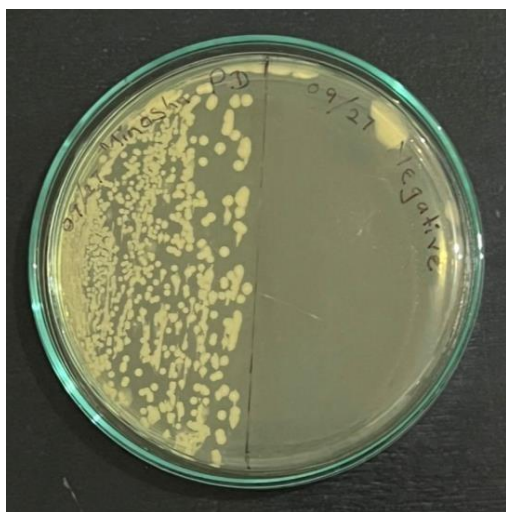


Figure 1. Image of the tap water culture plate of the Puttlam District (PD) (left) and negative control, post 24h (right).



Figure 2. Image of the positive control plate, post 24h.

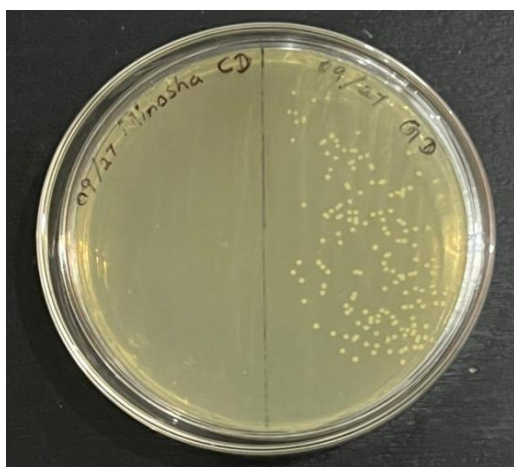


Figure 3. Image of the tap water culture plate of the Colombo District (CD) (left) and the Gampaha District (GD), post 24h (right).

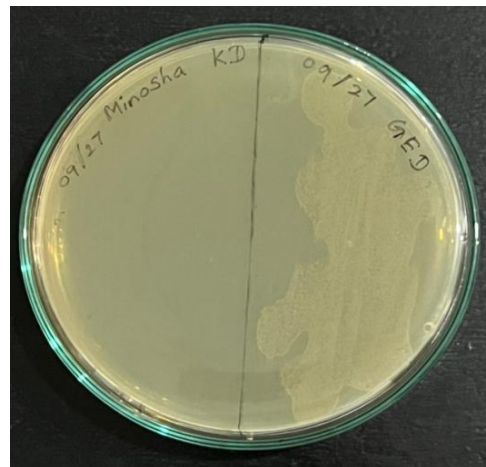


Figure 4. Image of the tap water culture plate of the Kalutara District (KD) (left) and the Galle District (GED), post 24h.

After completing the run, the gel image of the universal bacterial identification PCR was given below.

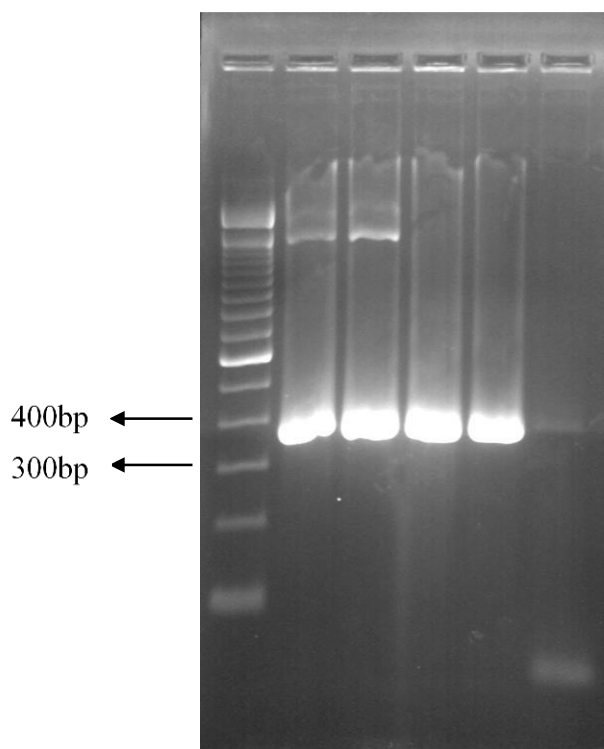


Figure 5. Image of the agarose gel electrophoresis of universal bacteria PCR

Table 1. Observation results of the universal bacteria PCR

Lane	Sample	Result
1	100bp DNA ladder	A band present
2	Puttlam district	A band present
3	Gampaha district	A band present
4	GED	A band present
5	Positive control	A band present
6	Negative control (distilled water)	Not a band present

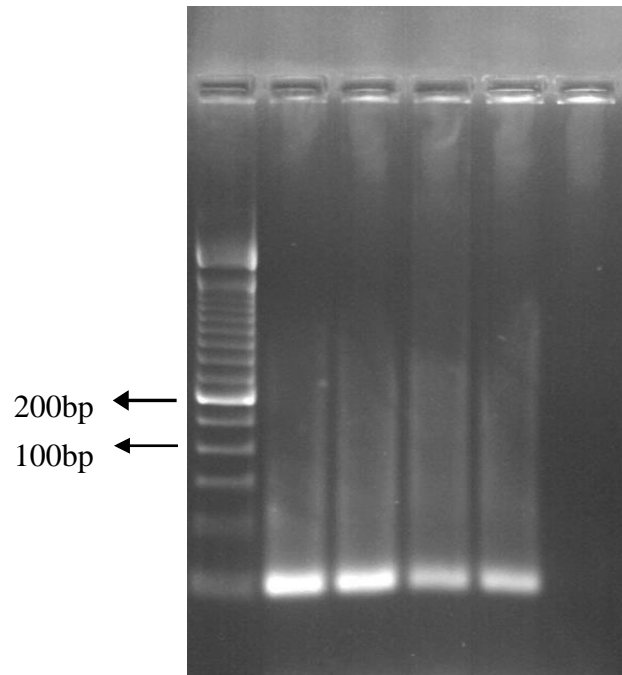


Figure 6. Image of the agarose gel electrophoresis of *E. coli* PCR

Discussion

Results of the culture plates Figure 1,2,3 confirm with the morphological characteristics can confirm it as *E. coli*. Because *Escherichia coli* colonies are typically classified as having either a rough or smooth morphology. The colonies of the two kinds can easily be identified from one another because those of the later are smooth, high, and circular, while those of the former are rough, flat, and irregular (Hasman, Schembri and Klemm, 2000). The band sizes of the gel images of universal bacteria and *E. coli* were equal to the results of the NCBI primer blast report of universal bacteria 371bp and *E. coli* 101bp with the primers. As there were bands observed from agarose gel electrophoresis of universal bacteria, an *E. coli* identification PCR was carried out to detect the possible presence of *E. coli* in tap water samples (Cabral, 2010). Bands in the gel image of *E. coli* appeared clearly and length of the bands 101bp were equal to the positive control, which is also the expected band size generated from *E. coli* specific primers. Therefore, from these findings can confirm as *E. coli* was present in Puttlam, Gampaha and Galle samples.

Conclusion and Recommendations

The water samples of Puttlam, Gampaha and Galle districts were contaminated with *Escherichia coli*, as confirmed by the band sizes in the gel images and morphological findings as well. In the NCBI blast report, the size of the bands showed the similar band lengths in universal bacteria and in *Escherichia coli* in the gel images. Overall, these preliminary findings are suggestive of a bacterial contamination of tap water in Puttlam, Gampaha and Galle districts. To validate this statement, further testing needs to be done to quantify total coliforms and compared to the WHO stated acceptable levels of coliforms in drinking water. Furthermore, sequencing of these water samples would reveal and validate

the presence of other bacteria in the tap water samples as found in the NCBI primer blast report.

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INFORMATION TECHNOLOGY

BIRDWATCH: A BIRD DETECTION MOBILE APP TO DETECT ENDEMIC AND CRITICALLY ENDANGERED BIRDS IN SRI LANKA

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Abstract

Monitoring and proper identification of wildlife species is a vital research area for preservation of the environment. This research has been conducted as an attempt to aid in the conservation of bird species in Sri Lanka. It describes the use of transfer learning for the purposes of image classification of 20 selected species of birds in Sri Lanka. MobileNetV2 with transfer learning has been used for the fine grained classification of the bird species and presently the model yields a test accuracy of 96%. Consequently, an Android application was developed and the model was embedded into it after being converted into tensorflowlite format. This is an application that can be used by birdwatchers to make inferences offline on the birds they come across.

Key Words: Bird Detection, Image Classification, MobileNetV2, Transfer Learning

Introduction

Sri Lanka is a popular destination for birdwatching owing to the fact that it houses up to 400 different species of birds, out of which 33 are endemic. However just as any wildlife species birds too face extinction in this island, mainly due to habitat loss. According to the National Red List of 2012, the main research need in this sector is the lack of information collected on birds which has hindered the formulation of species specific conservation plans (Weerakoon & Gunawardana, 2012). Therefore there is a need to monitor vulnerable, endangered and endemic species of birds in Sri Lanka and protect them. There is a need for birds to be studied further and bird research to be conducted. Birdwatchers are vital for this purpose. Bird watching, or the act of observing birds as a recreational activity started in the early 1900 in Great Britain and the US and continues till now. Although it seems like a passive activity, by observing and reporting on birds, birders have conserved the rarest of birders. Reporting on dead birds too helps conserve birds as the cause of death can be determined by autopsy and prevented if it is something preventable (Gomersall, 2020). Moreover the elusive nature of birds and the overall lack of awareness that people have about these species also act as deterrents to conducting studies on birds (Azwer, 2017).

As a tool to promote birdwatching and increase the awareness about these species of birds among common folk, a free app which can identify different bird species would be helpful. As the visual categorization of birds can sometimes be challenging due to the fact that there are subtle differences to look out for, a bird detection app will be helpful for beginner birders and bird enthusiasts. The detection of these birds can be done using deep learning, which is the go-to process for image classification ever since 2012 when the ImageNet Classification challenge broke accuracy records (Mirugwe, 2022). The main aim of this research is to

conserve the avifauna of Sri Lanka by promoting birdwatching among common folks and bird enthusiasts by providing them with a tool that can help them.

Methodology

For this work images of 20 species of birds have been collected, with 30 images compiled for each class, 10 of which are endemic species while the others are critically endangered species of birds. The next steps were to make the images ready for training. This included rescaling of the images to have values between 0 and 1, and resizing them to 224 by 224 pixels. Since the size of the dataset was small, data augmentation was carried out to artificially increase the number of training samples on the fly. This is an important technique to be used, as the model can only learn better when it has more data. Techniques such as rotation, shearing, width shift, height shift and zoom range were applied to the images. The training images were split into training and validation sets with an 80 – 20 ratio and there was a separate test set consisting of 6 images for each class. In addition to these 20 species of birds, images of species of birds that are currently not recognized by the app were also added so that the model can recognize them as invalid images. Once the data preprocessing step was done, the model was built using the transfer learning approach.

Transfer learning is the process of using a machine learning model that has already been trained to solve a separate but connected problem. Transfer learning's main tenet is to apply what has been learned in one activity to improve generalization in another. Instead of starting from zero, the learning process uses patterns that were found by completing a similar assignment (Donges, 2022). There are two primary approaches to transfer learning. The technique that was used for this work was feature extraction. This is the approach where we begin with the pre-trained model and the weights of the last layer are modified from which predictions are generated. As only the output layer is altered and the pre-trained model is used as a fixed feature extractor, it is called feature extraction (Knowledge Transfer, 2021).

The MobileNetV2 model has been used as the base model for this system. This model is lightweight and efficient and has been specially constructed to be deployed on mobile and edge devices. When observing the architecture of the model, it can be seen that a bottleneck depth-wise separable convolution with residuals is the fundamental component of it. MobileNetV2 begins with a fully convolutional layer with 32 filters, with 19 more bottleneck layers after it. Relu6 has been used for non-linearity owing to its robustness, and as a contemporary practice a kernel size of 3x3 has been employed with batch normalization and dropout throughout training. A constant growth rate has been employed across the network (Sandler, et al., 2019).

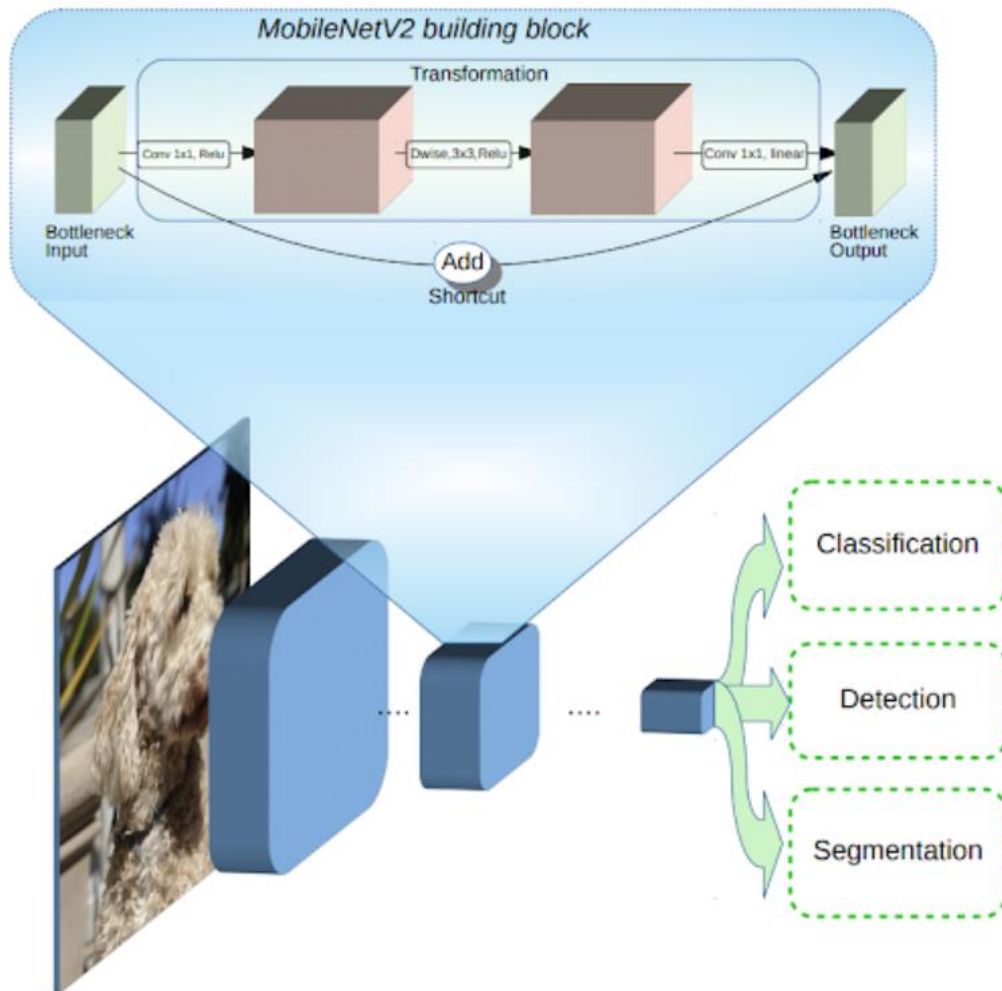


Figure 1: Architecture of MobileNetV2 (Sandler, et al., 2019)

For the classification layer, a Dense layer with 21 neurons were added to classify the 21 classes. In addition to that, another Dense and Dropout layer were added to improve feature extraction further.

Model: "sequential"

Layer (type)	Output Shape	Param #
keras_layer (KerasLayer)	(None, 1280)	2257984
dense (Dense)	(None, 512)	655872
dropout (Dropout)	(None, 512)	0
dense_1 (Dense)	(None, 21)	10773
=====		
Total params: 2,924,629		
Trainable params: 666,645		
Non-trainable params: 2,257,984		

Figure 2: Model summary

The model was trained for 15 epochs on Google Colab with GPU for its runtime environment, and achieves a validation accuracy of 91.22% and a test accuracy of 96.03%.

Results

The accuracy and loss graphs were plotted for this model.

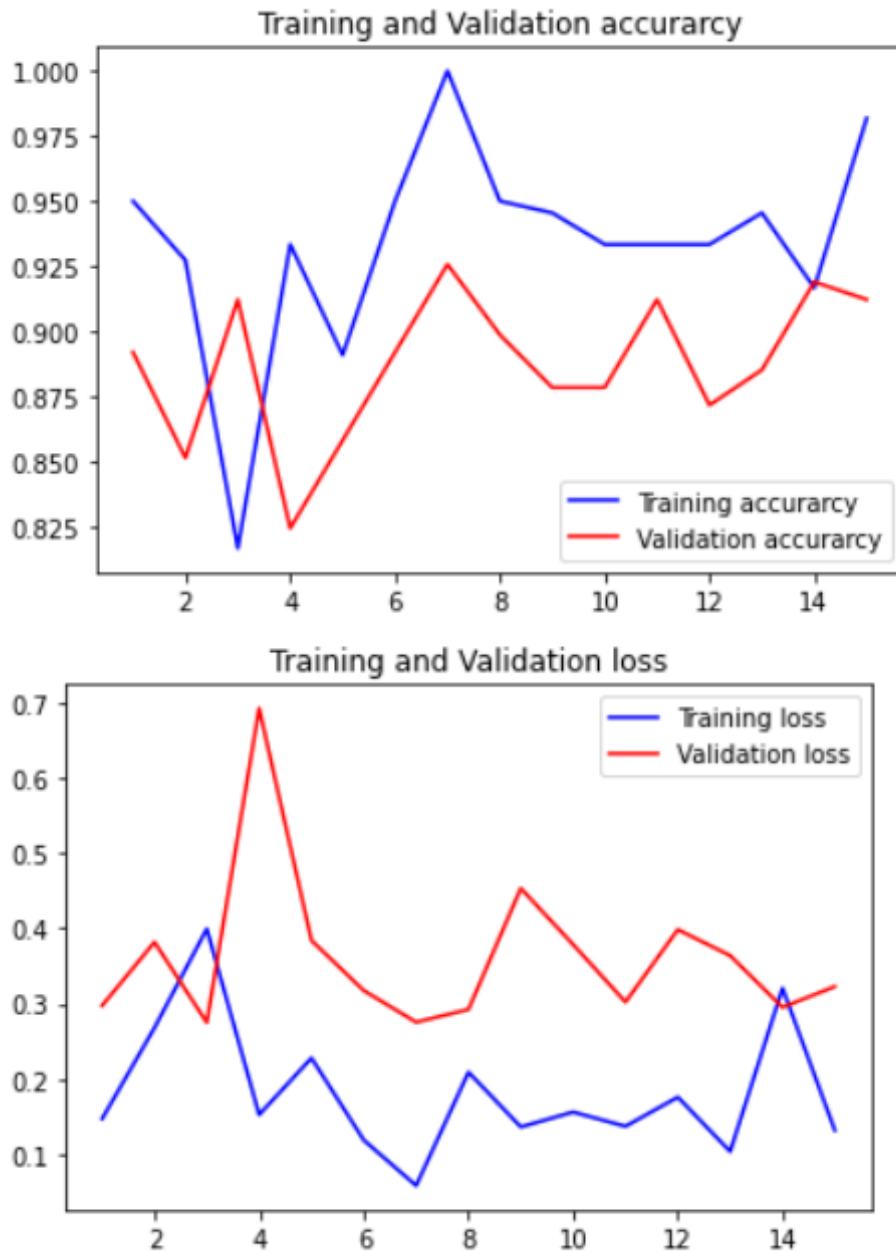


Figure 3: Accuracy and loss curves

The performance of the model was evaluated using a confusion matrix and a classification report. The confusion matrix visualizes how well the model predicts test data. The numbers along the diagonal show all the correct classifications while the numbers off the diagonals represent the incorrect classifications.

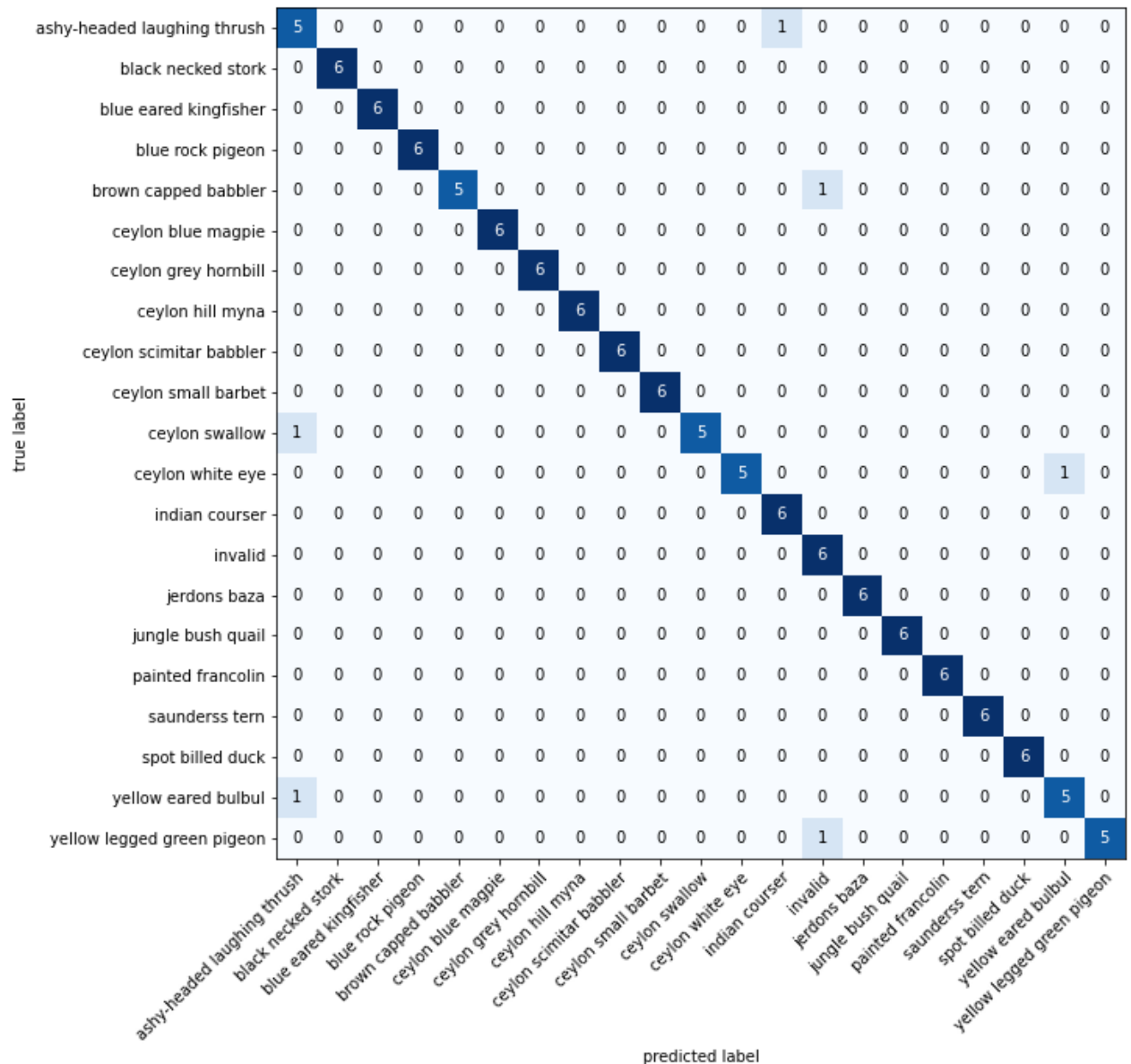


Figure 4: Confusion matrix

As can be observed by the confusion matrix, there are instances of misclassification in bird species such as Ashy-headed Laughing Thrush, Brown Capped Babbler, Ceylon swallow, Ceylon White eye, Yellow Eared Bulbul and Yellow Legged Green Pigeon, where only 5 of those 6 images have been correctly identified. However the other bird species have been predicted correctly. Despite few instances of misclassification, the model performs well as it gives accurate results for most of the bird species.

```
[51] print(classification_report(y_true, rounded_labels))
```

	precision	recall	f1-score	support
0	0.71	0.83	0.77	6
1	1.00	1.00	1.00	6
2	1.00	1.00	1.00	6
3	1.00	1.00	1.00	6
4	1.00	0.83	0.91	6
5	1.00	1.00	1.00	6
6	1.00	1.00	1.00	6
7	1.00	1.00	1.00	6
8	1.00	1.00	1.00	6
9	1.00	1.00	1.00	6
10	1.00	0.83	0.91	6
11	1.00	0.83	0.91	6
12	0.86	1.00	0.92	6
13	0.75	1.00	0.86	6
14	1.00	1.00	1.00	6
15	1.00	1.00	1.00	6
16	1.00	1.00	1.00	6
17	1.00	1.00	1.00	6
18	1.00	1.00	1.00	6
19	0.83	0.83	0.83	6
20	1.00	0.83	0.91	6
accuracy			0.95	126
macro avg	0.96	0.95	0.95	126
weighted avg	0.96	0.95	0.95	126

Figure 5: Classification report

Precision is a value that represents the amount of positive items accurately classified out of all positive items. Recall is the percentage of correctly predicted positive outcomes compared to all actual positive outcomes. F1 score measures the effectiveness of the identification as a whole, taking precision and recall of each class into account. An F1 score closer to 1 or 1 means the model performs well (Foss, 2018). The classification report shows that most of the classes have all these scores amounting to 1, while a few classes have low scores, nevertheless they are closer to 1. These evaluations validate the model further, and it can be said that the model performs reasonably well.

Discussion

The performance metrics conducted for this model show that this model is a reasonably well performing model. However considering accuracy and loss curves drawn for this model, it can be said that the model's robustness should be increased further. This research describes how effective transfer learning can be when the target dataset has some similarities to the dataset that the model has been trained on. It also shows the role of data augmentation to produce a good quality model when the dataset is small. Finally the model was embedded into an Android app, and this is convenient for the user due to its portability.

Conclusions and Recommendation

This research describes the use of MobileNetV2 with transfer learning for the purposes of fine-grained classification of 20 selected bird species of Sri Lanka. These birds were selected due to their status of being "critically endangered" or "endemic" as preserving them is of utmost importance. The main reason for the creation of this mobile app is to promote awareness about bird species in Sri Lanka. Bird watching is one of the hobbies that people take up that can greatly help in the preservation of birds and thus this app can act as a tool that can greatly help new birdwatchers to get started with their hobby of identifying birds. The app has strengths such as user friendliness, easy navigation, high performance and portability. However, the app serves as a starting point for birdwatching, but the user has to refer to a field guide or an expert in order to verify his observations. Its main limitation is it can only detect up to 20 birds at present. The number of species it identifies can be increased with more data in the future. More data will also help in reducing the misclassifications. In future, this app could be enhanced to include a feature where a user can record the birds they have observed into an online database that can be accessed by ornithologists. This will greatly help in the monitoring and conserving of birds. Since a bird can't just be identified by a picture alone, rather all its features and characteristics should be taken into account. Therefore a feature in the app where the birdwatcher can describe the bird in a few sentences and get suggestions for what type of bird it can be, will also be a useful feature for the future.

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SINHALA HANDWRITTEN CHARACTER RECOGNITION USING DEEP LEARNING

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Abstract

This research is focused on finding a method to developing a deep learning model to make Sinhala handwritten character recognition a possibility. The research directs on how such a system can be build with different parameters that are related with building an image recognition system that is variable to recognize characters. Sinhala language has a complex writing style therefore it has various issue in the context of HWR (Handwritten character recognition). These issues are addressed with practical solutions. The research goes over on how the character recognition system can be optimized to gain the highest possible performance. Preparation methods for a dataset are mentioned with techniques that can be used to source data and stored for the improvement of the neural network are also proposed.

Keywords: Sinhala handwritten character recognition, Neural networks, Artificial intelligence

Introduction

Sinhala is an Indo-Aryan language spoken by the majority of the population in Sri Lanka. It has a rich and ancient literary tradition, and the Sinhala script is an abugida, which means that each consonant has an inherent vowel sound (Deore, et al., 2020).. Handwritten Sinhala character recognition is an important problem that has received little to no attention from researchers in the field of pattern recognition and machine learning in comparison to other languages. Currently, optical character recognition is the predominant method for automating tasks, but its limitations in recognizing unique handwriting styles prevent it from being as flexible and accurate as it could be. However, by focusing on Sinhala HCR (Handwritten Character Recognition), we have an opportunity to enhance the flexibility and accuracy of our systems and bridge the gap in recognition capabilities. Adding support for Sinhala handwritten character recognition (HWR) would allow for automation of various systems such as postal services and reading bank cheques, which would increase efficiency in these tasks.

Objectives:

- Finding or creating dataset
- Creating SHCR deep learning model
- Optimization model for higher accuracy
- Methodology to gathering more data to improve the model

Methodology

SHCR can be approached in several methods, the selected methodology is to utilize deep learning. Deep learning uses a variety of layers to assist models to learn from the data and generate new insights. Self-driving cars, language translation, and natural language are common deep learning applications (Coursera, 2022) (JavaTpoint, 2021). Deep learning is also heavily utilized in the space of image recognition therefore considered an ideal candidate to accomplish SHCR. Foundation of any successful deep learning model is to have a proficient dataset to build upon. Due to Sinhala language not being prevalent topic in handwritten character recognition only 1 publicly accessible dataset was available. This dataset was published by Sathira Lamal to kaggle.com (Lamal, 2021) and needed heavy modifications in order to be viable. The dataset comes pre categorized into test and train data. Following is a list of modifications done to the dataset to suite the scope of this research

1. 31 characters were selected and categorized into classes for both test and train data
2. Added new data
3. Noise from the selected classes were removed from both sets
4. Images were downsampled to 50 x 50 pixels to increase performance

After modifications the train dataset averaged 170 images per class and test dataset averaged 23 per class.

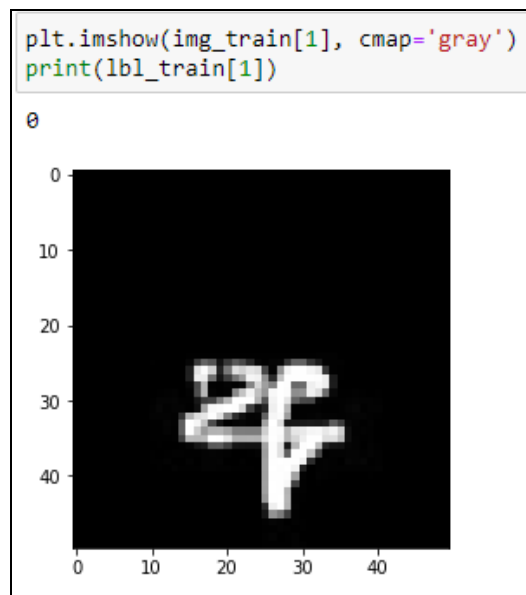


Figure 1: Preview of the modified dataset

A convolutional neural network (CNN) is a type of artificial neural network specifically designed to process data that has a grid-like structure, such as an image. It is particularly effective at image classification tasks. CNNs are composed of several layers of interconnected neurons. The first layer, called the input layer, receives the raw input data. The subsequent layers, called hidden layers, process the data through a series of mathematical operations called convolutions. The final layer, called the output layer, produces the model's prediction. CNNs are particularly effective for image classification tasks because they can automatically learn the features that are most important for the task, rather than relying on manual feature engineering. A 3-layer convolutional layer is built to accommodate SHCR.

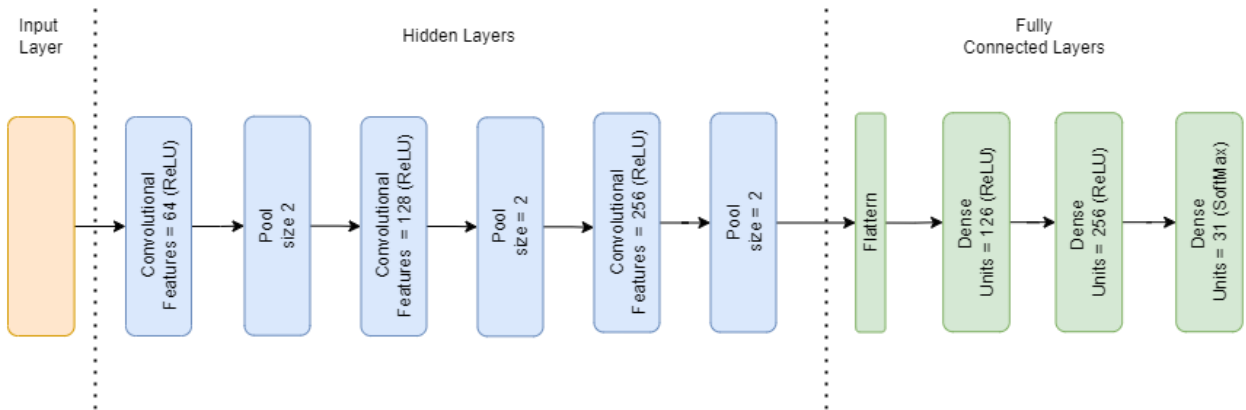


Figure 2: CNN architecture for SHCR

The feature count doubles up every consecutive layer starting from 64. Each layer is given a pool size of 2 and an activation method of ReLU. When training deep neural networks, the gradients of the parameters with respect to the loss function can become very small, making it difficult for the model to learn. This is known as the vanishing gradient problem. ReLU helps alleviate this issue by providing a non-zero gradient for positive inputs, which allows the model to learn more easily. ReLU is also more operational cost effective in comparison to Sigmoid and Tanh. In the classification layer SoftMax activation method is used because it converts little or negative inputs into small probabilities, and big or positive inputs into large probabilities, to fall between the values of 0 and 1. This allows the output of the CNN to be interpreted as a probability (Thomas Wood, 2022) (Furnieles, 2022). The dense layer has 31 units indicating that the model is only fitted with the capability of predicting 31 classes. Developing the neural network to recognize character modifiers in the Sinhala language is rather complicated. Some letters attach modifiers differently compared to majority. To combat the complexity the modifier needs to be attached to the character and should be considered its own unique character. To further elaborate character “ආ” is the “අ” character with a modifier attached to it and is treated as an entirely new character in the neural network. This increases the number of classes associated with the model and subsequently the size of the dataset, but keeps errors at a lower rate and favors performance by reducing any further processing required for the modifiers.

The neural network was trained with the batch size of 32 and 100 epochs.

Result

```
Loss : 0.26687091828149956
Accuracy : 0.9520349
Model saved
(directml) moeu@DESKTOP-I7KDT6A:/mnt/c/Users/Moe/Documents/GitHub/FP-app/model$ |
```

Figure 3: Model fit result

The model averaged at a 95.2% accuracy with a 26% loss on the test data set. which is respectable when considering the size of the dataset. For a proper conclusion the application needs to be tested against real world data, and the image below is a sample of real world test cases to prove that the application is viable.

	Prediction: 4		Prediction: 8	0 ඉ
				1 ඉං
				2 ඉූ
				3 ඉඳ
				4 ඉ
				5 ඊ
				6 උ
				7 එ
				8 ඒ
				9 ඔ
				10 ඔි
				11 ක
				12 ග
				13 ච
				14 ජ
				15 ට
				16 ඩ
				17 ණ
				18 න
				19 ද
				20 න
				21 ප
				22 බ
				23 ම
				24 ය
				25 ර
				26 ල
				27 ව
				28 ස
				29 හ
				30 ළ

Figure 4: Testing CNN with real world data

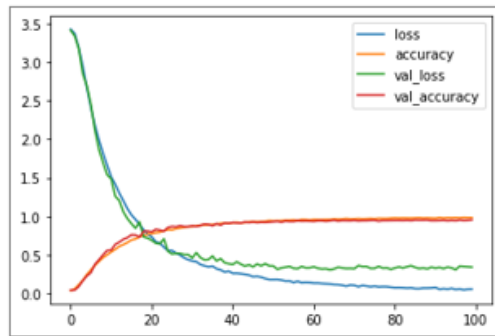
As depicted in the diagram green rows indicate correct predictions and the red row indicates the incorrect prediction. Due to the utilization of sparse_categorical_crossentropy the predicted classes are set to output as integer values, The respective integer values relevant to the character is represented on the right hand side table. From the above test data, the neural network was successfully able to recognize characters 89% of the time. Adding new data can potentially improve the accuracy and support a wider range of writing styles.

Discussion

The test results heavily lean towards positive results but it is important to optimize the neural network as much as possible. Different optimizers and learning rates have been used to find the most efficient performer for this neural network.

- Adadelta with a 0.01 learning rate

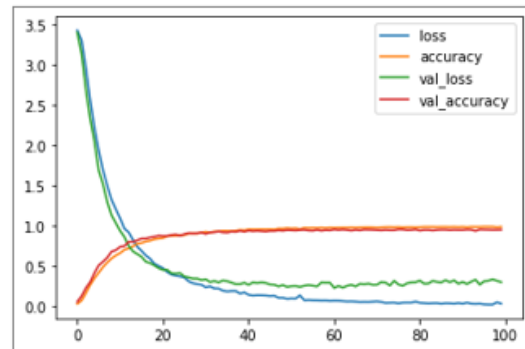
Loss: 0.34256869554519653
Accuracy: 0.9549418687820435



Adadelta optimizer graph

- Adam with a 0.0001 learning rate

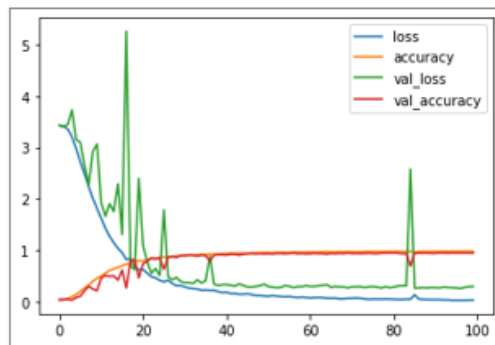
Loss: 0.30469855666160583
Accuracy: 0.9534883499145508



Adam optimizer graph

- Adagrad with a 0.01 learning rate

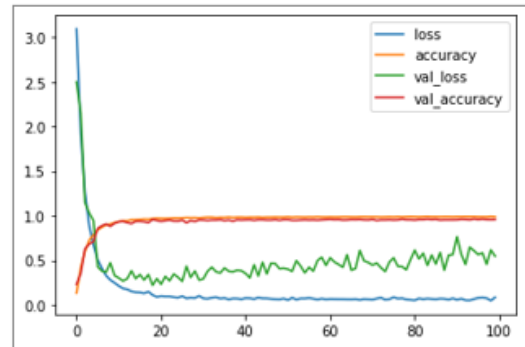
Loss: 0.30326205492019653
Accuracy: 0.9505813717842102



Adagrad optimizer graph

- RMSprop with a 0.001 learning rate

Loss: 0.5457886457443237
Accuracy: 0.957848846912384



RMSprop optimizer

Figure 5: Different optimizers and performance

The Adam optimizer had the most stable results at a learning rate of 0.0001 with the lowest loss. With more data, the neural network can achieve improved results and can support more characters. This can be addressed by developing an application with a drawable canvas that can extract the pixel values in to an array, then this array can be saved as a NumPy array. NumPy array files can be appended therefore it is easier to manage and is considered ideal to store a preprocessed dataset. For the purpose of this research two separate NumPy arrays files were utilized for labels and image data.

Conclusion and Recommendation

Though OCR for Sinhala exists there are no information sources on SHCR. Therefore, it is difficult to benchmark the results of this research with existing methodologies. By analyzing the outcome solely from this research it is safe to assume that this technology has a potential to excel given the right attention. With an improved dataset as well as more characters and increased amount of data per class, the neural network should be able to potentially recognize any handwritten Sinhala characters including modifiers. This can ultimately lead to the development of integrated systems mentioned in the above that utilize SHCR to perform its functions.

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VIDEO SURVEILLANCE (CCTV) SUSPICIOUS ACTIVITY DETECTION SYSTEM USING CONVOLUTIONAL NEURAL NETWORK (CNN) TO ENHANCE THE PROTECTION

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Abstract

The workplace, domestic and outdoor misconducts are also more common due to the current economic and social crises around the world (Vrskova, et al., 2022). According to that scenario, the research project was developed to solve the targeted modern security/safety problems in the world. The research project consisted of two key components. First, Deep Learning System to detect & upload the suspicious activities. Second, Native Mobile Application to access & manage those uploaded details and to receive notifications. These systems combination offered a highly effective way to approach human security, and when a suspicious circumstance occurred with the help of these technologies, the concerned parties can safely obtain information about it. To carried out the research, had the required resources, including time, knowledge, abilities, etc. as well as the system required improvement in order to be more efficient in terms of quality, accuracy, reaction time, and user experience.

Key Words: Suspicious Activity Detection, Convolutional Neural Network, Deep Learning, Video Surveillance.

Introduction

Closed-circuit television (CCTV), also known as video surveillance systems, perform a highly successful task in this situation and can be used to provide very effective security and safety. The CCTV system consists of cameras, recorders, and monitors or other display devices (Facilities Net, n.d.). A building or property can have this system configured for both the interior and outdoor zones. Here, the emphasis is on applying machine learning (ML) and deep learning (DL) to spot suspicious activities captured on closed-circuit television (CCTV) in order to reduce difficulties and increase the safety of both persons and properties. In order to train the models and detect suspicious activity by monitoring and live-capturing the video feeds, developed 3-Dimensional (3D) Convolutional Neural Network and Convolutional Long Short-Term Memory (ConvLSTM) Architectures for this system. That is the most effective technique to spot questionable activity in order to maintain vigilance and protection. Suspicious activity is automatically and precisely identified using the aforementioned deep learning technology, and the data is safely kept in firebase cloud databases and storages. Because of this, no additional human effort is needed, and the product is extremely precise and effective. Additionally, the recorded data is simple to utilize, and the mobile application promptly receives any suspicious activity, ensuring very good security and saving unnecessary time (Figure I).

Methodology

Due to COVID-19 and economic recession, many people have lost their livelihoods and jobs. Therefore, it is a very problematic situation for people to be tempted for illegal activities such as crimes, thefts, kidnappings, domestic violence, etc. Humans are exposed to very frightening and dangerous environments as a result of such actions, and there was a solution to use some technology to prevent such occurrences and lessen the risks. As the solution, two software systems were developed. First, suspicious Activity Detection Deep Learning System which implemented to automatically detect the suspicious activity, capture the records (date & time and snapshot images of suspicious behavior), and upload the suspicious activity details of video footages or live video capturing via CCTV to the Firebase cloud database. Second, Native Android Mobile Application which developed to register & login to user account, view suspicious activity details such as date & time and snapshot images of the incident, get notifications of the suspicious activity count and manage suspicious records by accessing the Firebase cloud database. This neural network-based frameworks are utilized to train spatiotemporal features for detecting suspicious activities. These frameworks were all inspired by deep learning video detection. In long-short-term memory (LSTM) networks and convolutional neural networks (CNN) are used in succession to learn spatial and temporal data. Built a deep 3D ConvNet to directly learn spatiotemporal characteristics and excelled at several sorts of video analysis jobs (Riahi, et al., 2022). Using 3DCNN to learn the spatiotemporal properties of each video and learn spatiotemporal characteristics are the better methods.

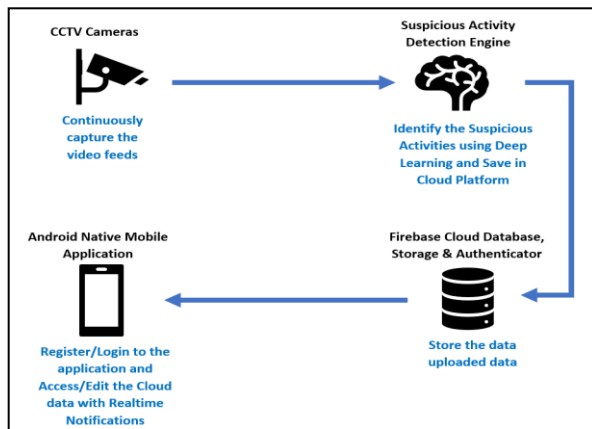


Figure I: System Architecture

Model: "sequential"		
Layer (type)	Output Shape	Param #
conv3d (Conv3D)	(None, 55, 55, 10, 128)	15616
conv3d_1 (Conv3D)	(None, 26, 26, 10, 64)	204864
conv_lstm2d (ConvLSTM2D)	(None, 26, 26, 10, 64)	295168
conv_lstm2d_1 (ConvLSTM2D)	(None, 26, 26, 10, 32)	110720
conv_lstm2d_2 (ConvLSTM2D)	(None, 26, 26, 10, 64)	221440
conv3d_transpose (Conv3DTranspose)	(None, 55, 55, 10, 128)	204928
conv3d_transpose_1 (Conv3DTranspose)	(None, 227, 227, 10, 1)	15489
Total params: 1,068,225		
Trainable params: 1,068,225		
Non-trainable params: 0		

Figure II: Model Summary

Epoch 992/1000	10/10 [=====] - 7s 655ms/step - loss: 0.0140 - accuracy: 0.8747
Epoch 993/1000	10/10 [=====] - 7s 653ms/step - loss: 0.0139 - accuracy: 0.8745
Epoch 994/1000	10/10 [=====] - 6s 648ms/step - loss: 0.0135 - accuracy: 0.8750
Epoch 995/1000	10/10 [=====] - 7s 662ms/step - loss: 0.0136 - accuracy: 0.8750
Epoch 996/1000	10/10 [=====] - 7s 656ms/step - loss: 0.0135 - accuracy: 0.8750
Epoch 997/1000	10/10 [=====] - 6s 647ms/step - loss: 0.0136 - accuracy: 0.8749
Epoch 998/1000	10/10 [=====] - 7s 655ms/step - loss: 0.0145 - accuracy: 0.8751
Epoch 999/1000	10/10 [=====] - 7s 653ms/step - loss: 0.0147 - accuracy: 0.8751
Epoch 1000/1000	10/10 [=====] - 6s 648ms/step - loss: 0.0146 - accuracy: 0.8751

Figure III: Model Training

Normal Event	0.0005438168529126205
1/1 [=====] - 0s 183ms/step	
Normal Event	0.0005457355296341179
1/1 [=====] - 0s 193ms/step	
Normal Event	0.0005625348783727331
1/1 [=====] - 0s 190ms/step	
Normal Event	0.0005915616725115485
1/1 [=====] - 0s 204ms/step	
Suspicious Activity Detected	0.0006353669175018723
1/1 [=====] - 0s 170ms/step	
Suspicious Activity Detected	0.0006528121160860201

Figure IV: Suspicious Activity Detection Result

For handling OpenCV, there are two options in the Runtime analysis. Both the GPU (Graphical Processing Unit) implementation and the CPU (Central Processing Unit) implementation fall under this category. Since OpenCV is a computer vision-based system and is therefore primarily concerned with graphical operations, my analytical recommendations suggest that the GPU implementation is preferable to the CPU implementation in this comparison. According to it, the GPU rather than the CPU uses the higher performance.

Results

An experiment is deliberately changing one or more independent variables and assessing the impact on a few dependent variables. Thus, this deep learning experiment needs to execute multiple learning runs, each under a different set of circumstances. In the scientific process, experimentation is the stage that aids in choosing between two or more competing explanations, or hypotheses. These theories offer rationales to explain a phenomenon or forecast the outcomes of an action.

Evaluate the Performance of the Model in Keras – Data Splitting (Automatic Verification Dataset)

Data splitting is the process of dividing a set of available data into two sections, typically for cross-validation needs. Sometimes it referred to as train-test split, is the division of data into smaller subsets for separate model training and evaluation. According to this Evaluation, the batch size was set to 1 and the epoch size was 1000 in the dataset training model. After the model had been trained, the average train loss was 0.013135, and the average train accuracy was 0.8753781. The model's accuracy was almost 90% based on these results expressed as a percentage (Figure III, V).

Analytical Test/Prediction Results

The analytical testing and selected a threshold value for Suspicious Activity Detection; it is 0.00060 for the video file feed process and 0.00062 for the live video capturing feature (Figure IV, VI). This valuation results might be changed according to the different environmental situation such as light conditions, visibility, etc. This type of identification pattern allows the system to detect all suspicious occurrences, including fights, robberies, explosions, criminal activity, theft, and other events.

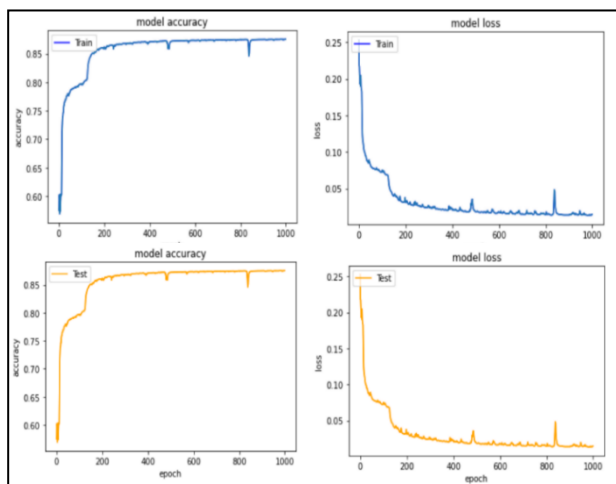


Figure V: Model Training Accuracy & Loss Curve

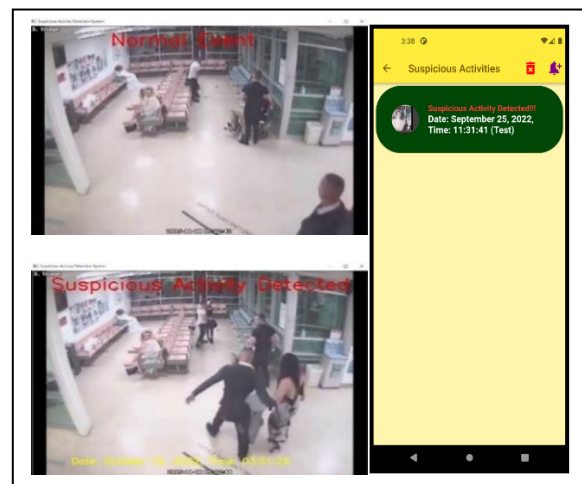


Figure VI: Detection Accuracy of Tested Results & Mobile App Result

Model Evaluation

A Keras model evaluation can help to avoid the underfitting/overfitting trap (When the loss is more than it should be because the model has not learned enough signal, the training set is being underfit. When the loss is more than it should be because the model learned too much noise, the training set has been overfitted). Before training the model, certain data were taken out of the training set and kept aside, known as the testing dataset. The model's practical applicability might be more certain (TensorFlow, n.d.). A validation set was used during training to basically verify the model at each epoch. Additionally, did not have to wait for a complete set of epochs to finish in order to have a better notion of the model's actual performance (Keras, 2020). The model performed stochastic gradient descent (SGD) on the cross entropy over the training dataset using the Adam optimizer, and then delivered the final accuracy on the testing dataset. The error metrics were computed on the validation dataset and recorded in the history at the conclusion of each epoch. The model was assessed on the testing dataset at the end of the fitting loop, saved, and maybe deployed for use. There were some other Evaluation methods as well such as, Confusion matrix, Precision, Recall, Specificity, F1 score, Precision-Recall or PR curve, ROC (Receiver Operating Characteristics) curve and PR vs ROC curve (Jeremy Jordan, 2017).

Discussion

The Network Architecture, in order to learn the spatio-temporal (Zhang, et al., 2018) properties of the live video capture and the video file feed for this project's suspicious activity detection system, expanded deep neural networks to three dimensions. In order to enhance the protection, the creation of a spatio-temporal autoencoder that is built on a 3-Dimensional Convolution Neural Network (3DCNN). A frame was first rebuilt by the decoder after the encoder harvested the spatial and temporal information. The suspicious activities were discovered by calculating the reconstruction loss using the Euclidean distance between the original and reconstructed batch. For the model training, used two datasets in order to learn spatio-temporal features: ShanghaiTech Campus dataset (Anomaly Detection) & Theft Detection Dataset (Kaggle). These datasets feature examples of typical human behavior like jogging, strolling slowly, conversing, dancing, and other activities. There are 480 video segments totaling 6.74GB in size. For the data training process, employed sequential seven layers (Figure II), including Conv3DTranspose, ConvLSTM2D, and two Conv3D layers, in accordance with the spatial autoencoder design. The selection of the "Adam" optimizer as the optimizer since it was an optimization technique that may be used in place of the conventional gradient descent stochastic procedure to iteratively update network weights based on training data.

Conclusions and Recommendations

As the Conclusions, Considering the various security reasons and security issues that exist in the world, the research to protect people and their valuable property through machine learning has been solved. In order to effectively executed the research, must carefully consider whether had the necessary tools, expertise, skills, time, and other resources and it was crucial to assuring the quality the deep learning system and the mobile application. Each

function's functionality should be tested to ensure it was correct. To minimize any processing hangs or lags, different program components should also be evaluated to function flawlessly together. The user-experience bug and glitch rate were decreased during the testing phase. As the Recommendations, Enhancing the system with more effective in terms of quality, accuracy, response time, and user experience. Try to integrate a live online viewing capability with the system's implementation of the detection of suspicious activity so that users can view their live cameras online while being tracked for suspicious behavior. Develop this system as a commercial level application by conducting full scale technical investigation and use the premium quality of frontend and backend resources such as premium web services, optimized data models, etc.

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MACHINE LEARNING AND DEEP LEARNING BASED WEB APPLICATION FOR BREAST CANCER PREDICTION

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Abstract

Breast cancer is a major health concern that affect many individuals worldwide leading towards an increase amount of breast cancer deaths every day. This brings up the need to introduce a computer based prediction system using machine learning and deep learning approaches to accurately predict the occurrences of the breast cancer. The goal of this study is to identify top performing algorithms for detecting the breast cancer using clinical data and images. Wisconsin Breast Cancer Diagnostic dataset and Breast Cancer Histopathological Image Classification dataset were used for training the model and the performances of the algorithms were evaluated with respect to precision, sensitivity, confusion matrix and accuracy. Out of the algorithms tested, the most efficient algorithms were identified as SVM and CNN with an overall accuracy of 97.14% and 95.65% and were then integrated into a web application for effective recognition of the breast cancer. In the future, the website will be further enhanced with security measures considering the ethical issues that can rise as a result of obtaining the confidential health data of the users.

Keywords: Machine Learning, Deep Learning, Breast Cancer Detection, SVM, CNN

Introduction

Breast cancer is found to be the leading cancer in the world with a high mortality rate. It has been discovered that approximately 50% of women with breast cancer are treated at a later stage. As per cancer mortality statistics, breast cancer is found to be the highest age standardised death rate among female cancers in 2006, which is of 4.7/100,000. In 2009, it increased dramatically to a crude rate of 22.3 per 100,000 people and an age-standardized rate of 22.2 per 100,000 worldwide populations (National Cancer Control Programme, 2014). Breast cancer is discovered to be extremely dangerous because it is a metastatic disease that can spread to distant of the body such as the liver, bones, brain, liver, and heart, making it incurable (Sun, et al., 2017). Currently, the breast cancer prediction is performed by utilizing methods such as: Clinical breast examination, Breast self-examinations and through Mammography and/or using Ultrasound Scan (National Cancer Control Programme, 2014). Out of those, Mammograms plays a major role in breast cancer screening as it helps to diagnose breast cancer before signs and symptoms are felt. A mammogram is produced in the form of an X-ray image, in which during a mammogram the breasts are pushed between two solid surface to capture the signs of cancer (Dongola, M, 2020). However, these traditional methods have resulted in producing more errorful results, leading the patients' lives towards danger. Breast cancer is more treatable and has a greater probability of survival if detected accurately at an early stage.

With the development of the computer technology, the artificial intelligences approaches such as machine learning and deep learning can be utilized to effectively overcome the

drawbacks of traditional breast cancer detection methods (Rangayyan, et al., 2008). Furthermore, given the amounts of data generated in the field of healthcare and technological innovation, machine learning and deep learning approaches provide promising outcomes. These technologies aids in the extraction of data and knowledge from prior experiences, as well as the detection of difficult-to-perceive patterns from huge and noisy datasets, which leads towards producing accurate outcomes over the traditional breast cancer detection methods. Thus, application of machine learning and deep learning in the field of breast cancer prediction is identified as a highly effective approach in the recent years (Prasath Alias Surendhar & Vasuki, 2020).

The primary objective of this study is to develop a web based prediction model using Machine Learning and deep learning algorithms for the early detection of breast cancer. Top rated few algorithms will be utilized and will be compared based on accuracy, sensitivity, specificity and precision to identify the highly accurate algorithms to deploy in to the web application for predicting the breast cancer using clinical data or image as inputs. This web based predictive model will be effective in promoting the patient's wellbeing and to correctively classify the patients into malignant and benign groups by using the patient's data and image as inputs.

Methodology

The identification of the best algorithm for predicting the breast cancer using the data was performed by first analysing the performances of few machine learning algorithms such as Support Vector Machine (SVM), K-Nearest Neighbors (KNN), Naïve Bayes (NB) and Classification and Regression Trees (CART) on the Breast Cancer Wisconsin Diagnostic dataset and the results of each algorithm were then compared to identify the algorithm that offers a higher accuracy. The proposed architecture is shows in figure 1.

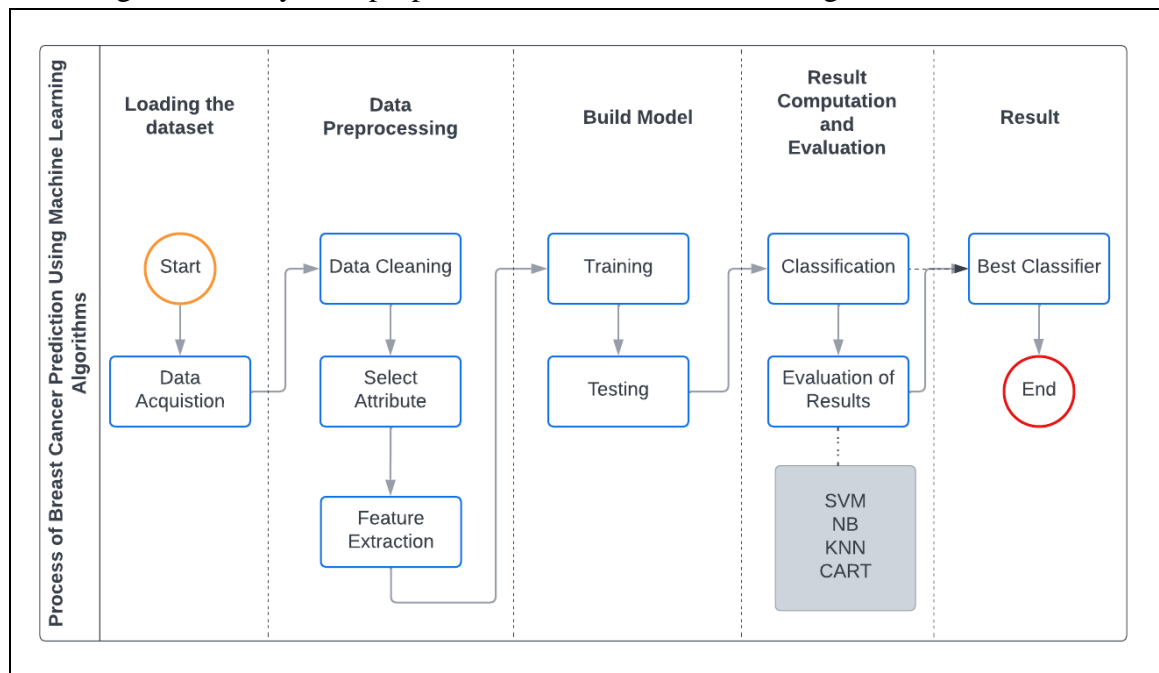


Figure 1: Process of Breast Cancer Prediction - Method I

The methodology commences with data acquisition, and is then followed by data pre-processing. A Categorical Variable Conversion is performed using the Label Encoder to transform the non-numerical values found in the ‘Diagnosis’ column for the dataset, which shows the type of the cancer as M = malignant or B = benign to a numerical label format as most of the algorithms produce better result with numerical variable. Then Feature scaling was performed to bring the features of the dataset to the same level of magnitudes. Then the prepared data is utilized for building the machine learning model for predicting the breast cancer. 70% of the data was allocated for training the machine learning model and 30% of the data was allocated for testing the performances of the model. A 10-fold cross validation for each testing is performed to improve the model performances. After performing the testing, the results will be compared to identify the algorithm that produce high accuracy and low error.

The next major objective of the study is to recognize the most accurate algorithm for the prediction of breast cancer using the images. To achieve this objective few deep learning algorithms such as ResNet-50, DenseNet121 and CNN were applied on the Breast Cancer Histopathological Database (BreakHis) dataset and results of each algorithm were compared to identify the algorithm that offers a higher accuracy. The proposed architecture is shown in figure 2.

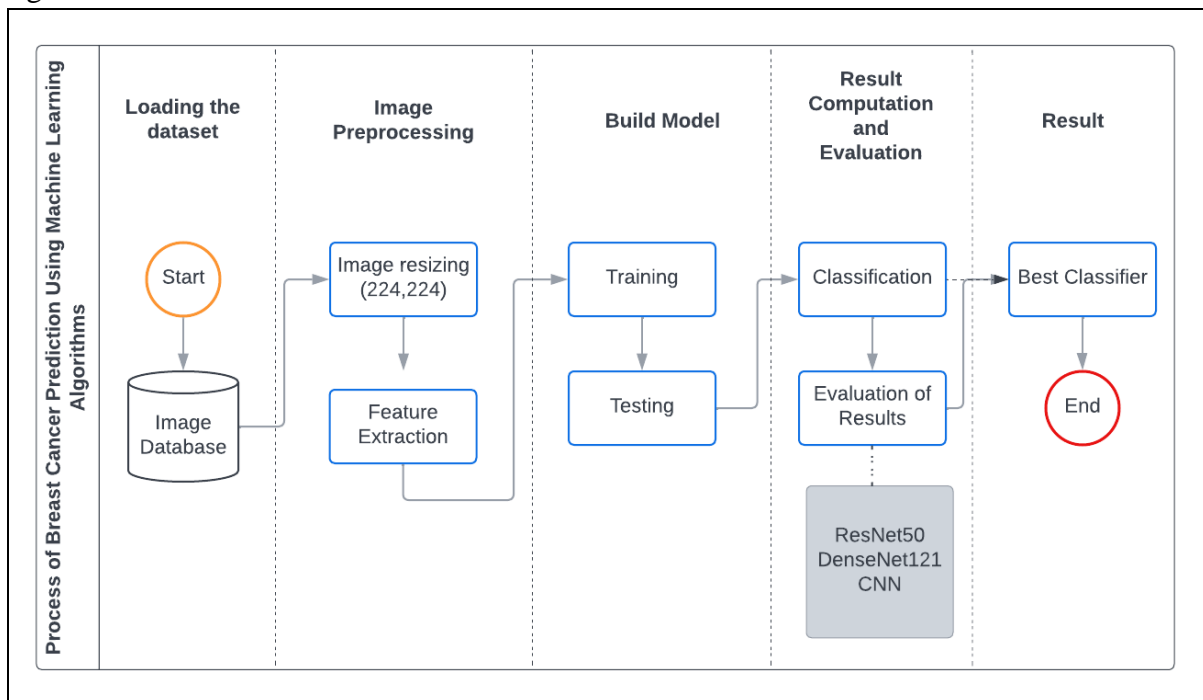


Figure 2: Process of Breast Cancer Prediction - Method II

Results

The results obtained for each methods are given below.

Method I (Detection of breast cancer using data)

The Table 1 and Table 2 below displays the results of the performances of the algorithms upon successful implementation of the algorithms on the breast cancer dataset.

Algorithm	Accuracy	Recall	Precision	F1 Score	Class
CART	90.47%	0.90	0.96	0.93	Benign
		0.93	0.81	0.86	Malignant
SVM	97.14%	0.98	0.98	0.98	Benign
		0.96	0.96	0.96	Malignant
NB	95.23%	0.96	0.96	0.96	Benign
		0.94	0.94	0.94	Malignant
KNN	95.71%	0.96	0.97	0.97	Benign
		0.95	0.94	0.94	Malignant

Table 1: Accuracy and Classifiers performances

The Table 1 above shows the results of the classification models based on accuracy along with precision, recall, f1 score for benign and malignant classes. The chart below displays the results sketched in the basis of the accuracy.

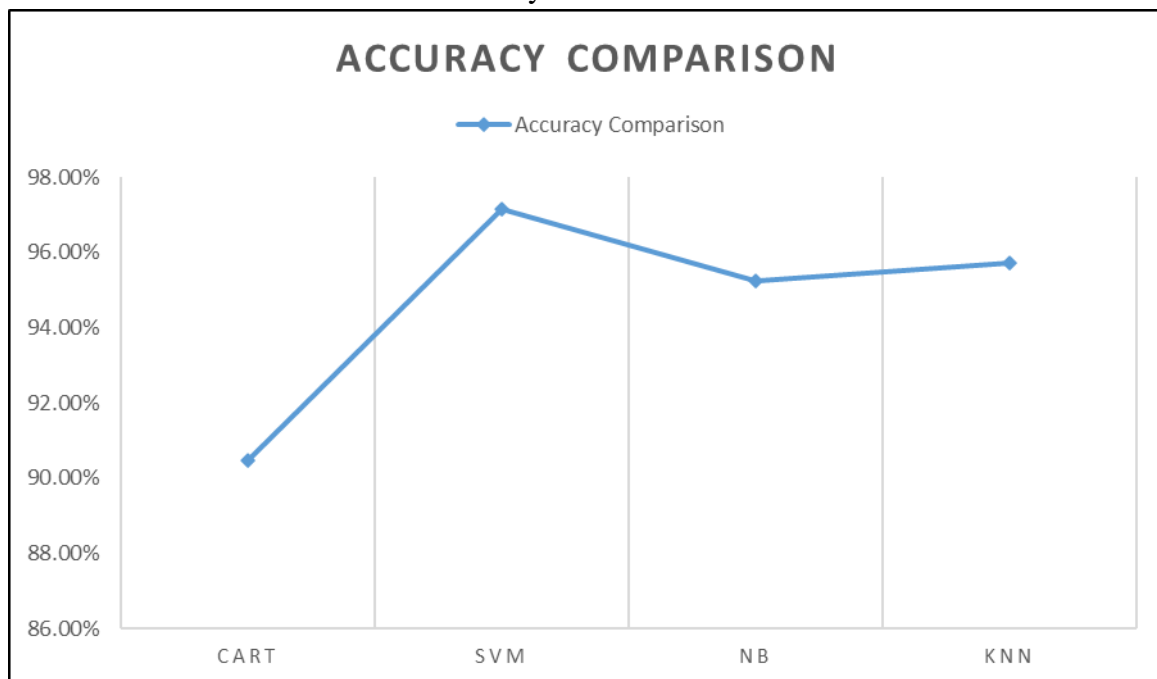


Figure 3: Accuracy Comparison

When looking at the results displayed in the chart above, it is clear that SVM outperforms the rest of the algorithms with an accuracy of 97.14% which is higher when compared to the accuracy of CART (90.47%), NB (95.23%) and KNN (95.71%). The values of precision,

sensitivity and F1 Score of SVM for Benign class was 0.98 whereas for Malignant class was 0.96, which is higher than that of other algorithms.

Method II (Detection of breast cancer using Images)

The model utilized accuracy, loss, validation loss and validation accuracy criteria to compare the algorithms performances on the dataset for recognizing the best performing algorithm. The respective results obtained for ResNet-50, DenseNet121 and CNN is shown on the table below.

Algorithm	Loss	Accuracy	Validation loss	Validation accuracy
ResNet-50	21.85%	92.51%	19.09%	94.78%
DenseNet121	21.08%	92.70%	16.78%	95.65%
CNN	11.83%	95.04%	8.68%	95.65%

Table 2: Performance Comparison Method II

The Table 2 above presents the performance measures of the classification models based on Loss, Accuracy, Validation loss and Validation accuracy. The values of the validation loss and validation accuracy are taken here as the standard measurement criteria's to decide on the highest performing algorithms. When looking at the results of each algorithm, it is clear that CNN and DenseNet121 has a higher validation accuracy value of 95.65% and stands as the top algorithms when compared to ResNet-50 which has a validation accuracy of 94.78%, which is comparably lower than CNN and DenseNet121. But the validation loss of DenseNet121, which is 16.78% is comparably higher than the validation loss of CNN which is of 8.68%. The validation loss of ResNet50 has a higher value of 19.09% and stands as the lowest performance algorithm among the rest of the algorithms.

Moreover, in order to function as the best performing model, the validation loss of the model should reduce along with the increase of the validation accuracy. The Figure 4, Figure 5 and Figure 6 below shows the performance of the CNN, DenseNet121 and ResNet50 models.

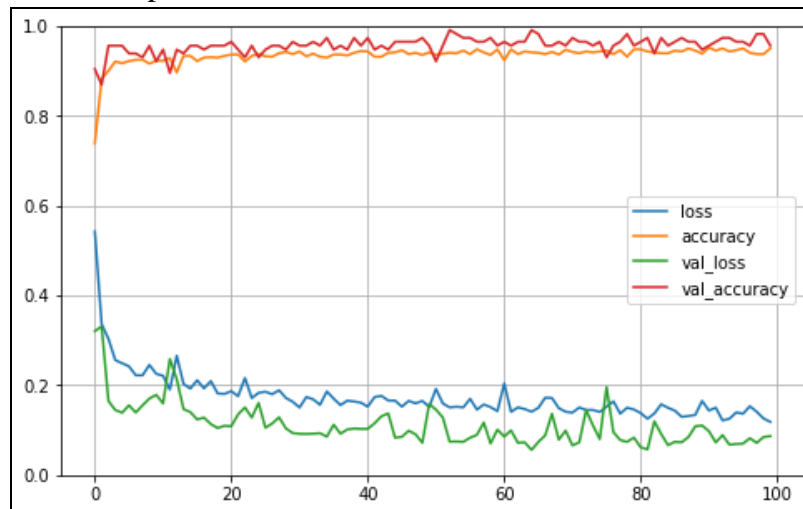


Figure 4: CNN algorithm Performance

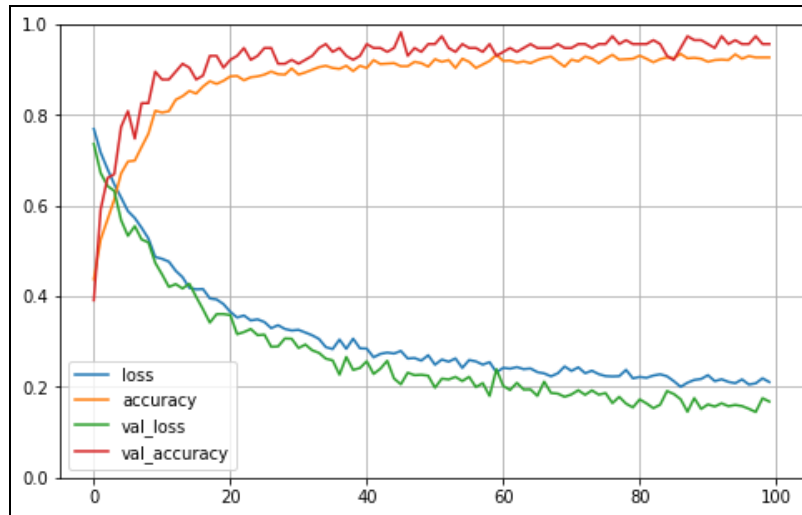


Figure 5: DenseNet121 algorithm performance

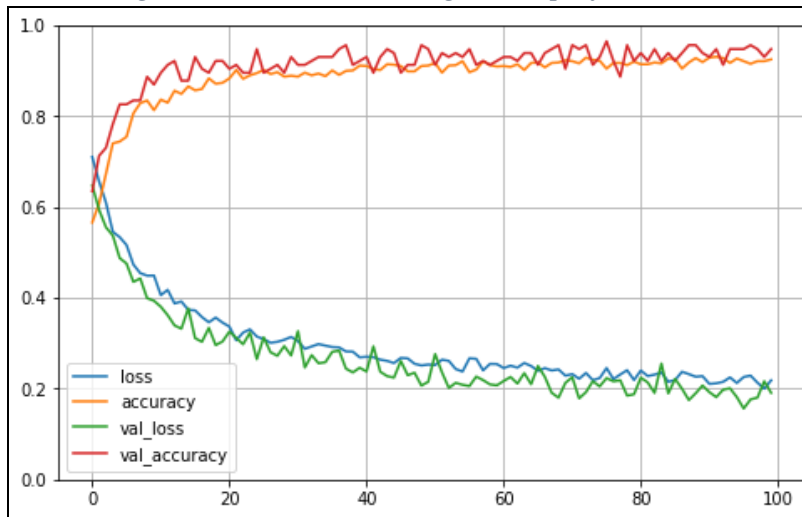


Figure 6: ResNet50 algorithm performance

When looking at the diagrams above, it is possible to see that all the three models functions well each of the models validation loss has started to gradually decrease while increasing the validation accuracy along with the increase of the number of epochs. Thus, after taking all the results of the performances of the algorithms into an account, it can be concluded that the performance of the CNN mode is comparably higher when compared to ResNet50 and DenseNet121 in terms of both validation accuracy and validation loss. Hence, CNN stands as the highest performing algorithm for predicting the breast cancer using the images.

Discussion

As per the results obtained above, it can be clearly seen that SVM machine learning model outperforms the CART, NB and KNN algorithms in detecting the breast cancer using the data (Method I) and CNN deep learning model outperforms the ResNet50 and DenseNet121 algorithms in detecting the breast cancer using the images (Method II). Thus, SVM and CNN stands as the best performing algorithms to deploy into the web application for predicting the breast cancer using data and images as raw inputs. Thus, the core of the website is developed using two algorithms for predicting the breast cancer using the data and images, making the functionality of the website more advanced. The user will interact with the breast cancer

prediction system via a simple web application. The user has the option for predicting the breast cancer by inputting an image/data or by inputting both type into the website. And then the backend of the system will provide the results to the user with the use of the previously trained model.

Conclusions and Recommendations

This study was conducted to examine the best available machine learning and deep learning algorithm for detecting the breast cancer using data and image as inputs. The performances of the algorithms were measured based on confusion matrix, accuracy, sensitivity and precision. After performing a comparison between accuracy of the models, it was found that SVM outperforms the rest of the machine learning algorithms and CNN model outperform the rest of the deep learning algorithms for predicting the breast cancer using images by producing a validation accuracy of 95.65%. In the future, the website will be integrated with advanced security measures for securing the patients data to minimize ethical issues that can rise from the confidential health data of the users. And also the training of the machine learning models will be improved with more extensive datasets to further characterize the breast cancer into several classes with high accuracy.

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NATIONAL FUEL DISTRIBUTION SYSTEM(NFDS) USING AUTOMATIC NUMBER PLATE RECOGNITION WITH MASK CONVOLUTION NEURAL NETWORK

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Abstract

With no substantial fuel arriving in Sri Lanka, multiple days-long queues were built up near the filling stations across the country. Several people have died while on the fuel queues, and thousands of work hours were wasted daily around the queues. This paper addresses the challenges of managing vehicle fuel queues at filling stations and identifying solutions to reduce waiting time. “National Fuel Distribution System” help fuel pumpers scan vehicle number plate and effectively dispense fuel according to license plate number. The license plate is located using the deep learning concept known as Mask Region Convolution Neural Network (Mask R-CNN). After the recognition of the vehicle license plate, next, the image is preprocessed to remove noise using a range of thresholds before being submitted to Tesseract OCR. Tesseract OCR, an API for character recognition, is utilized to extract the character from the preprocessed image.

Keywords: Mask R-CNN, Tesseract OCR, ANPR, Machine Learning (ML), COCO Mask R-CNN, ROI pooling

Introduction

Since the beginning of 2020, the foreign exchange reserves of Sri Lanka began to deplete due to higher demand than the ability to earn through exports, loans, and other capital inflows. The situation is far worse because the disposable reserve amount is lower than the gross amount. Due to the decrease in foreign exchange, it became difficult for Sri Lanka to import essential goods such as fuel and medicines. With no substantial fuel arriving in Sri Lanka, private motorists, farmers, fishermen, and even production industries ended up queuing for hours, even days, for their fuel quota shortage of fuel stocks leads people to have to be in line for days to get fuel. Several deaths while in fuel queues marked the grim indication of people's suffering, and outside of filling stations, fights between civilians, police, and defense officials happened all over the country. Most of the fuel queues were over miles long, and people even obstructed roads with their vehicles, demanding solutions. Those struggles ultimately fueled mass protests demanding reforms and the resignation of corrupt officials that led to unparalleled events in Sri Lankan history. And after the people's demands, the government started to look into a solution that could manage fuel distribution in a controllable manner. To overcome these issues, a number of strategies were put into practice, and the management issues with fuel distribution have been solved to some extent.

This is a web-based software called the “National Fuel Distribution System (NFDS)” that is the solution to solve long fuel queues near fuel outlets in Sri Lanka. Through this application, implement a system that can scan and identify the vehicle license plate, connect the client and

the filling station in real-time, and manage fuel consumption and distribution. The pumper can scan the vehicle number plate, read the vehicle allocated fuel availability along with the requested volume from the client and dispense fuel.

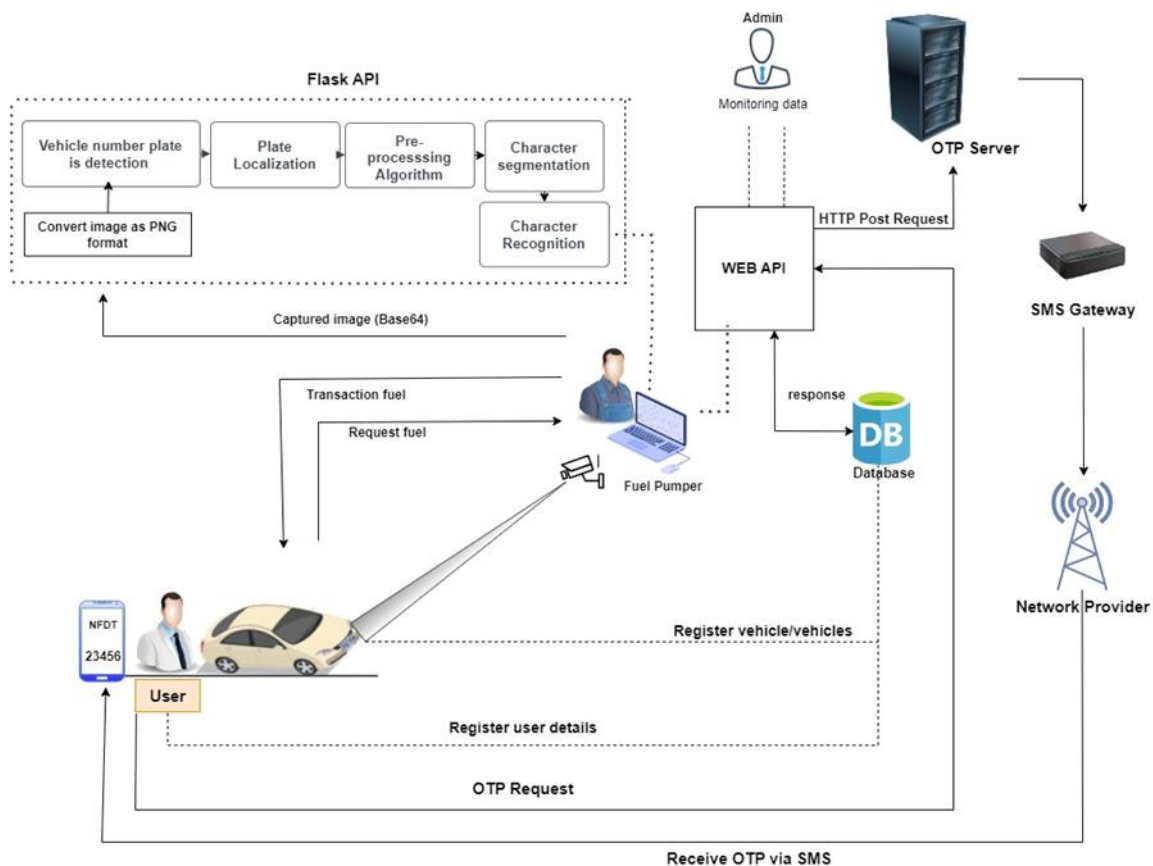


Figure 1: System Design

Methodology

The backbone of the National Fuel Distribution System is developed using ML architecture. This vehicle number plate detection model was mainly developed using two steps.

1. Vehicle number plate detection
2. Vehicle number plate recognition

A large dataset of images of vehicles was required to train the model in its first stages. As a result, gathered images of vehicles from several websites (Patpat.lk, ikman.lk), as well as from personal collection, with the intention of ensuring that the model would be able to recognize number plates in a variety of real-world situations. After that, each image was manually labeled using Makes Sense AI tool by boxing in the license plates and assigning numbers to them. It was essential to verify that the model could recognize number plates appropriately. The annotated data aids in training the algorithm to identify the location, size, and shape of license plates in vehicle images. Standardization, data augmentation, and image-processing methods including flipping rotating, and scaling was used to further diversify the dataset. As a result, there were more unique training instances and the risk of overfitting was reduced.

The well-annotated and diverse dataset was split into training and validation sets. The training set was used to train the model, while the validation set was used to evaluate its

performance during training and to tune its hyperparameters. In this research, 500 images in PNG format were used and multi-layered neural network architectures are used to train the model. The initial 7:3 split of the training and test sets resulted in 350 images for the training set and 150 images for the test set.

Trying different architectures is an important step in developing an accurate and reliable ANPR model. Mask RCNN is a popular object detection architecture that can be used for this system. Mask RCNN combines the advantages of semantic segmentation and object detection, two important computer vision tasks. It can both recognize and segment objects in an image to determine their exact boundaries. This is significant in the case of vehicle number plate detection because it enables the model to locate the number plate and distinguish it from the other vehicles.

This AI model uses the Mask RCNN, to find the vehicle license plate from the provided image. To find the object from the given data, the Mask RCNN and the picture containing the detected object are utilized.

Character recognition model designed to recognize and classify individual characters, such as letters and digits, from the recognized vehicle number plate. The common approach is trained on a large dataset of character images and their corresponding labels. The neural network then learns to extract features from the images and make predictions about the character class based on those features

After the first step, the image is preprocessed to remove noise using a range of thresholds before being submitted to Tesseract OCR. Tesseract OCR, an API for character recognition, is utilized to extract the character from the preprocessed image. This implemented vehicle plate number processing system combines image processing and neural network technology to detect the characters accurately. Tesseract OCR, which groups the connected blobs of pixels into lines, then groups the lines into characters, and finally segments each character according to word space, accomplishes this automatically. Tesseract can recognize white text on a dark background; text outlines are created by nesting pixels into blobs, which are then linked together and added to a character cell based on the character spacing.

The following steps are required to set up the Mask RCNN framework using the Matterport implementation:

- Install required dependencies, such as TensorFlow, Keras, and the COCO API: Installing necessary dependencies is the initial step.
- Download the Matterport Mask RCNN repository: This repository contains pre-trained weights and other resources required for using the model.
- Configure the model: This includes specifying the number of classes, the size of the input images, and the number of training steps and preparing the dataset.
- Train the model: This involves running the training script and specifying the path to the dataset. The training process has taken more than 24 hours to train this model for 50 epochs.
- Evaluate the model: After the model has been trained, then evaluate it on a validation dataset to measure its accuracy.

To improve the model's accuracy, different combinations of parameters such as the number of epochs, step size per epoch, and learning rate. The model was initially trained for 10

epochs, and its performance was evaluated using a validation set. Then increased the epochs to 30 and 50 to test if the model's accuracy was improved. Although this strategy did boost accuracy, it also extended the training period. Next, tried out several step sizes per epoch value to see how they affected the performance of the model. For the developed use case, noticed that a step size of 10 produced the optimal performance. Author also tested by changing the learning rate, testing with values between 0.001 and 0.01, determined that my model performed best with a learning rate of 0.001.

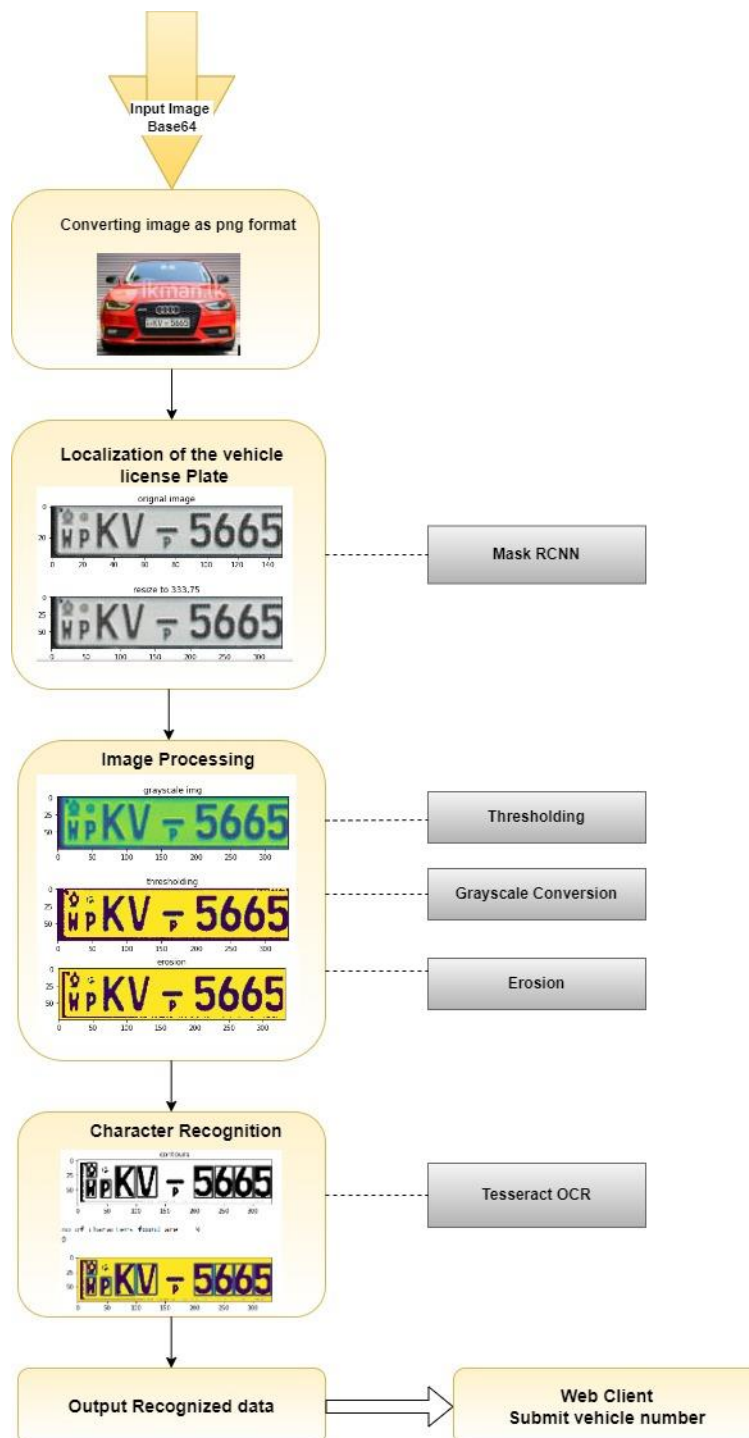


Figure 2: ML Model Architecture

Results

At the first, the epoch was set to 30, with each epoch having 50 steps and its result is shown in figure 3. In the next step, the epoch was set to 50, with each epoch having 50 steps and its result is shown in figure 4. The loss graphs for each partial function in this study are shown in the figures below.

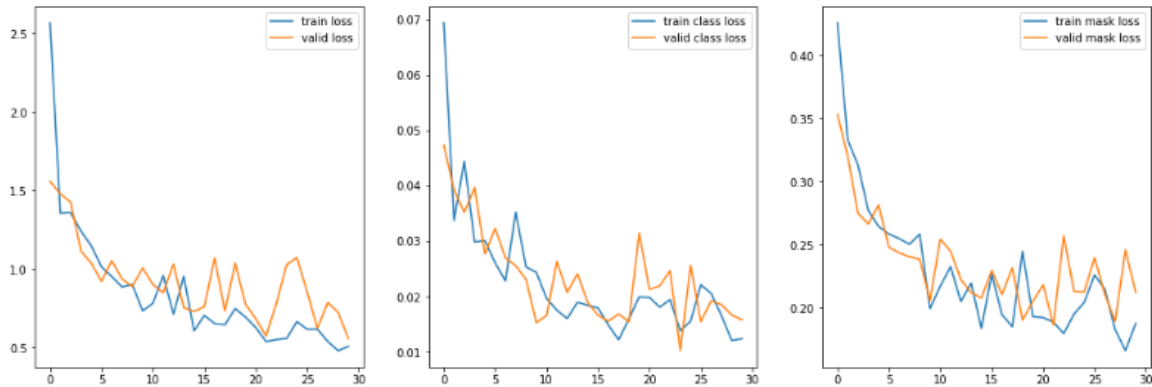


Figure 3: Mask R-CNN loss results for 30 epochs

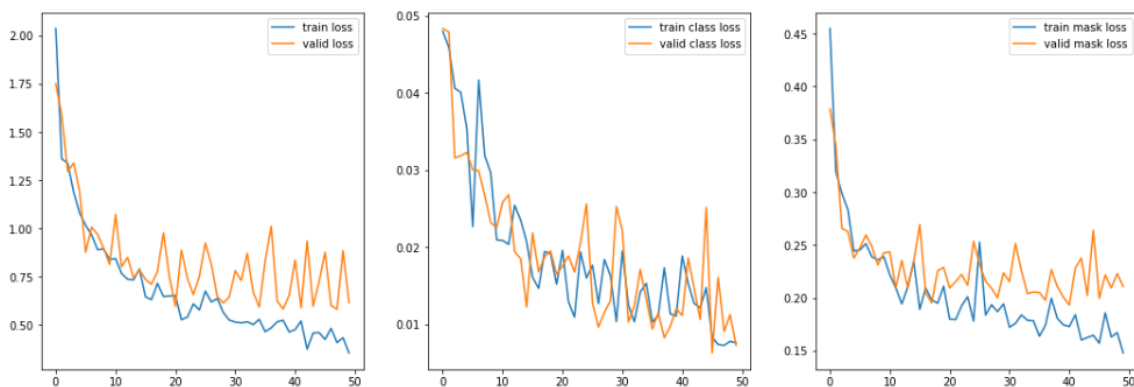


Figure 4: Mask R-CNN loss results for 50 epochs

According to figure 4, once the learning rate was set to 0.001, the training loss decreased to 0.3547 and the validation set loss dropped to 0.6153. The RPN class loss decreased to 0.0020 in the training set and to 0.0027 in the validation set. The Mask R-CNN head bounding box loss decreased to 0.0579 in the training set and the validation loss decreased to 0.0621. RPN bounding box loss decreased to 0.1393 in the training set and the validation loss was 0.2783.

```
50/50 [=====] - 3284s 66s/step - loss: 0.3547 - rpn_class_loss: 0.0020 - rpn_bbox_loss: 0.1393 - mrcnn_class_loss: 0.0076 - mrcnn_bbox_loss: 0.0579 - mrcnn_mask_loss: 0.1479 - val_loss: 0.6153 - val_rpn_class_loss: 0.0027 - val_rpn_bbox_loss: 0.2783 - val_mrcnn_class_loss: 0.0073 - val_mrcnn_bbox_loss: 0.1164 - val_mrcnn_mask_loss: 0.2107
```

Figure 5: Mask R-CNN loss results

The illustration below shows how a suggested web application may reliably identify a vehicle's license plate.

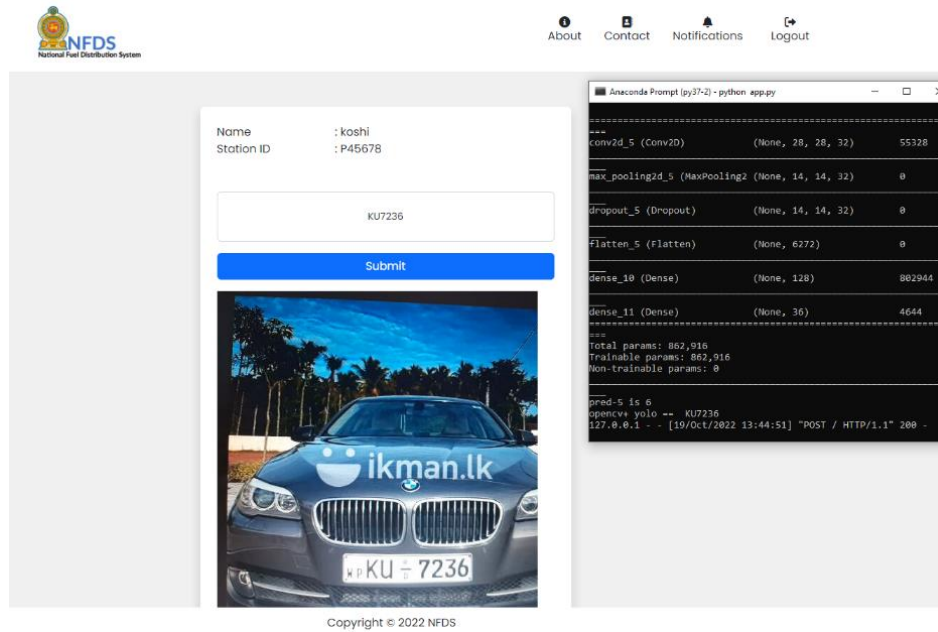


Figure 6: Vehicle number plate detection for a tested result

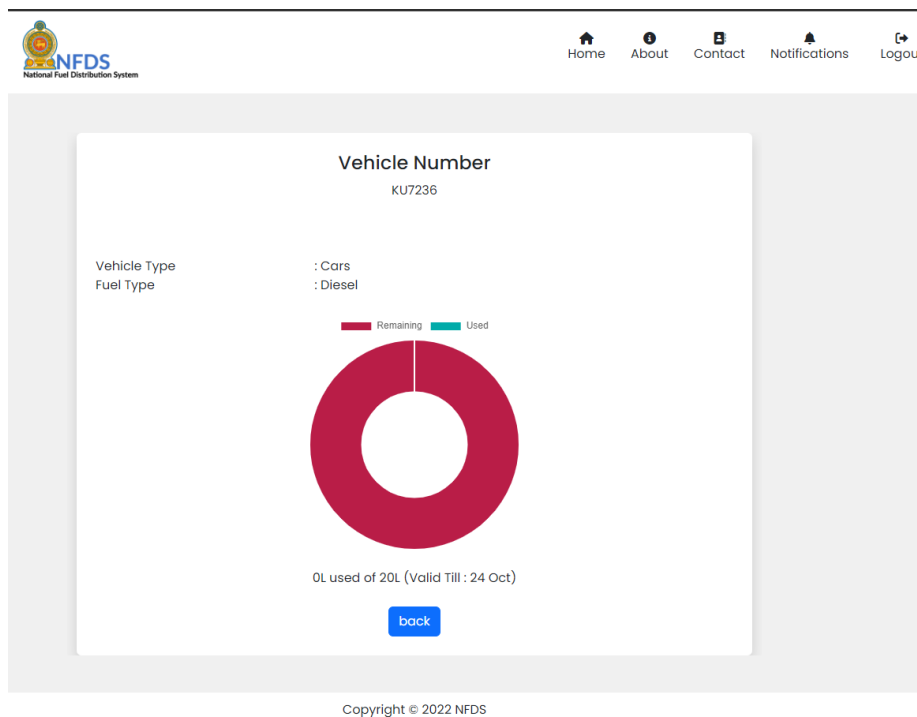


Figure 7: Available and used fuel amount according to the vehicle number plate

Discussion

Computer vision technology has grown in popularity due to its robust object identification and classification in industrial and various technological applications. This strategy can be applied to fuel distribution in Sri Lanka. The main importance is to outpace the problems that are skipped with current practices and gain more ability to carefully manage limited fuel reserves and improve efficient consumption. More controlled distribution and real-time monitoring through the system will reduce over/fraud consumption which ultimately helps to

stop crowd gatherings near fuel outlets and thus will reduce traffic issues, time waste, etc. By adding a new mask branch, Mask R-CNN offered a greater level of accuracy. The disadvantage was obvious as well: its detection speed was only 5 fps. Regrettably, its effect was clearly noticeable in slow processing at the stages of development with high recognition accuracy.

The total loss, which was divided into 50 training epochs with 50 steps each, shows that the model performed well in this training. The RPN bounding box loss signified the loss of the RPN bounding box, the RPN class loss defined anchor classifier loss, the Mask R-CNN bounding box loss defined the loss of the Mask R-CNN bounding box refinement, the Mask R-CNN class loss defined the head layer loss of the classifier of Mask R-CNN, the Mask R-CNN mask loss defined the head layer mask the binary cross-entropy loss of Mask. When considering the results, the degree to which the training model correctly predicted the class was indicated by the classification loss. In contrast to RPN class loss, which only covered the foreground and background of images, masks R-CNN class loss addressed all objects. On the other hand, the border loss was affected by the separation between the actual and predicted boxes. How closely the model matched the expected proper class mask is determined by the Mask R-CNN mask loss. The total loss was equal to the sum of the losses.

Conclusion and Recommendations

This paper discusses fuel distribution management for a busy filling station with artificial intelligence by applying the Mask R-CNN algorithm during the fuel crisis in Sri Lanka. The ANPR technology has been used in a wide range of fields currently. Examples in toll gates, in-vehicle parking services, and speed(law) enforcement (Syed Zakir Ali, et al., 2019).

Many ANPR systems have been developed based on different platforms and concepts. (Reda Al-batat et al, 2022) This research team uses a YOLO-based end-to-end Automatic License Plate Recognition (ALPR) system. This pipeline is generic, which means it does not require any prior knowledge or additional steps. The system is accountable for three functions: vehicle detection (VD), license plate detection (LP), and recognition. The entire ALPR pipeline is evaluated, from detecting the vehicle to recognizing the license plate. A classifier is also included in the system to distinguish between emergency vehicles and heavy trucks. The research by (Jaskirat Singh, Bharat Bhushan, 2019) implemented an ANPR system that performs better than before suggested ANPR systems in a variety of difficult contexts. The purpose of this research is to develop a reliable method for detecting license plates in images using deep neural networks, pre-processing the plates that are discovered, and then performing license plate recognition (LPR) using the LSTS Tesetract OCR Engine. Their test results show our system was successful in producing reliable results with LPD accuracy of 99% and LPR accuracy of 95%, which are comparable to commercial ANPR systems like Open-ALPR and Plate Recognizer.

The research done by (Druki A.A., Bolotova J.A, Sptsyn V.G, 2015) studied the vehicle number plates detect in the complex background image. The majority of their discoveries were, however, long-term solutions to different issues. This implies that it will take longer to get positive results. Taking long-term solutions into account when thinking of Sri Lanka is challenging. The web application can recognize vehicle number plate characters with a high

accuracy rate even when the confidence rate drops as a result of the well-trained dataset. This study is a quick and effective answer to the issue, which has a significant impact on every stage of society.

This method is not compatible with all sorts of vehicles. The model will not end up producing the desired outcomes if the images are captured under different lighting conditions. If the images are shot from different perspectives and against different backgrounds, the results won't be correct. When the background was the same colour or white, the results were, for the most part, better. In order to solve the many severe vehicles and light situations of vehicle number plate recognition, it is vital to develop and expand the application work in the future. At the same time, Sustainable Technology can improve the adoption and manufacturing of devices with autonomy and intelligent data and machine learning systems. In order to deal with data, security is crucial.

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MACHINE LEARNING BASED ANDROID APPLICATION FOR IDENTIFY INDIGENOUS SNAKES

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Abstract

Sri Lanka boasts one of the highest rates of biological endemism in the world whether in plants or animals and is included among the top five biodiversity hotspots in the world. However, people are not aware of animal species such as snakes since they do not have appropriate knowledge about them. This abstract presents an empirical analysis of the performance of the popular Convolutional Neural Networks (CNN) for identifying indigenous snakes in real time. The aim of the research is to use machine learning and image classification for the “Click-Snake Android Application”. The final outcome of this project was to build a Machine Learning platform, in terms of a mobile application, which would serve as real-time snake identification with high accuracy.

The implementation of the proposed project was done by Android Studio and Tensorflow lite. Java and XML. Convolution Neural Networks (CNN) was used as the Image classification methodology. After successfully implementing an Android Application to identify more than 8 snakes in real time without using the internet it was possible to reach an accuracy of more than 85% for most snake identification. After login in by using email users can use the Application to identify snakes. Machine learning and image processing were used for this App. Users can identify snakes within a few seconds with good accuracy which leads to better education about snakes and make sure their survival in the nature.

Keywords: CNN, Image Identification, Machine Learning, Object Identifying, Snake Identification

Introduction

Sri Lanka is a country that has the highest number of snake bites in the world. Because of the highest biodiversity in the country, many snake species can be found anywhere in the country. Sri Lankan snake fauna comprises 100 species belonging to 10 families. This application makes people aware of what snake species are generally found in Sri Lanka.

Considering the previous research on the same areas, Mohini Niraj Sheth and her team proposed an image-based snake identification system by using the principal component analysis (PCA) algorithm and they had 80% of accuracy in 2018. (Sheth, Nalbalwar and Nandgaonkar, 2018)

The work of Izzati Rusli and the team investigated the accuracy of five machine learning algorithms - naive Bayes, nearest neighbors, k-nearest neighbors (kNN), back-propagation neural network, and decision tree J48 for image-based snake identification problems. In their work, they got 75.54% with Naïve Bayes 87.63% Back-propagation neural network, 89.22% nearest neighbor, and 71.29% with Decision tree J48. (Izzati Rusli et al., 2019)

Various methodologies were identified in the image classification context by going through many research papers. However, most of those projects needed an internet connection to identify snakes and had an accuracy of less than 90%.

Testing was done with test cases however testing was not included on Different Oss, Earlier versions of Android platforms, Stress Testing/ Load Testing, Closing accounts in the App and changing email/mobile numbers.

The main aim of the application is to help the public identify snakes easily and to help to protect snakes.

Methodology

CNN are going to use the Image classification methodology. CNNs are specially used in Computer Vision Applications that involve Image Classification and Object recognition. Snake recognition is a combination of both Image Classification and Object Recognition. CNN receives an image as a three-dimensional matrix. A snake observer is always using these characteristics to recognize the snake species. Those characteristics are the Length and shape of its body, Head and neck shape and color pattern on its body, pass through the layers while identifying various features and predicting the class or label of the image. (Sheth, Nalbalwar and Nandgaonkar, 2018)

CNN has three types of layers as follows: Convolutional Layer, Pooling Layer, and Fully-Connected Layer. The convolutional layer is the brain of CNN. It identifies the features of an image. Normally there are multiple convolutional layers. The first convolutional layer is responsible for identifying high-level features of an image. (HernándezSerna and Jiménez-Segura, 2014) Pooling Layer is common to add a pooling layer between two Convolutional layers in a CNN. The purpose of a pooling layer is to reduce the dimensionality of the feature maps generated in the Convolutional layer. It helps to reduce the needed computational power and training time to train the network. In the fully-connected layers, it takes all the input from previous layers and flattens it into a feature vector to predict the output probabilities. ”. (Abayaratne, 2019)

To train a CNN from scratch, huge computational power and time is needed. CNN gives accuracy when there is a huge amount of data. If there is a small amount of data, at the training time CNN would be over-fitted and give inaccurate results. To overcome these issues, transfer learning is used. In transfer learning pre-trained models can be used which were trained on a huge dataset. (Bloch et al., 2020)

Image dataset was collected through web sites and from a student who is researching snakes. The dataset includes images of snake species which contain both test and train images. There are 1500 train images and 400 test images in the dataset.

The following diagram describes the complete architecture of the application how mobile trained machine learning models interact with each other. When there is connectivity mobile application receive the results by call the hosted Machine Learning (ML) model in the server to achieve better performance. When there is no connectivity, it gets the results through the Machine Learning (ML) model deployed inside the mobile application.

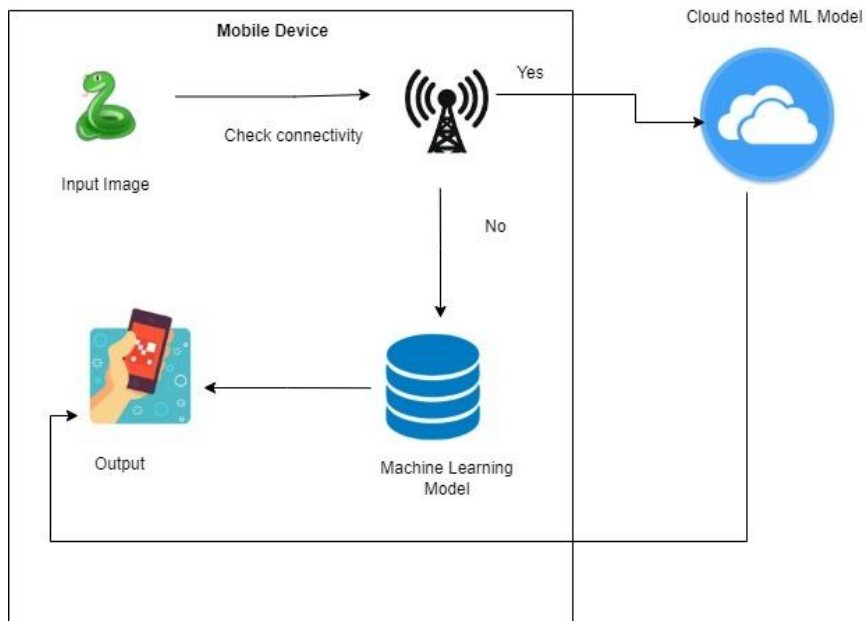


Figure 1: Architecture Diagram

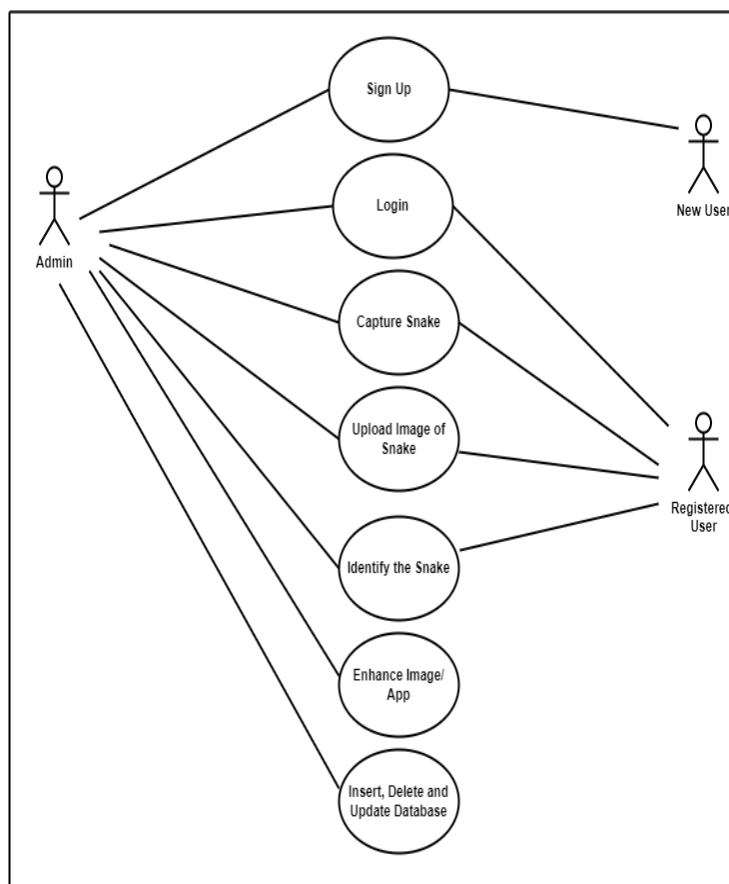


Figure 2: Use case Diagram

Since the App is having mainly two types of users, use-case diagram illustrates the system as above. After sign-up by giving correct data users can login to the account and use the App freely. After sign-up/register users can use the entire feature in the App.

From the Sign up Page users can enter their Name, Valid Email Address, Valid Mobile Number and Valid Password and sign-up for the system. They'll get a user's account after this process and they can login to the account afterwards.

After successfully sign-up, users can login to the account by using Email and Password that they used for Sign-up.

Result and Discussion

After finalizing the project proposal, questionnaire was created to gather the information about snakes. The questionnaire was filled by the society through social media and real-time. More than 20 participants participated for the questionnaire. From that questionnaire information was gathered about how people are reacting to a snake, why people are reacting to a snake like that and how to help the people as well as the snakes.

There were 1500 train images and 400 test images in the data set. In total, 1900 images were collected. 78.94% were train images and 21.05% were test images.

Table 1: Data Set Sizes

Train Images	1500	78.94%
Test Images	400	21.05%
Total Images	1900	

From this Application, users can identify more than 8 snakes within a few seconds, however the accuracy of each identification was more than 85% for each snake. Testing phase was done for the Application to get the test results of accuracy.

Russell's viper, King cobra/Indian cobra and Green snakes are the most common snakes in this Application.

Table 2: Highest Accuracies of Main snakes

Snake Name	Accuracy
Russell's viper	97%
Indian cobra	99%
Green snake	96%

Table 2 represents the highest accuracy that got for few snakes of this Application. That was the highest accuracy for each snake that we got from the testing phase. Other accuracies also were more than 80%-90% for most of the snakes.

In the testing phase the application was not able to show the same accuracy for each snake type in every testing attempt, for some cases got less accuracy.

Table 3: Report of Accuracies

Accuracy for a snake	Times we got the accuracy	Percentage
75%-77%	0.2	20%
78%-80%	0.25	25%
81%-83%	0.555	55.5%
84%-87%	0.6	60%
88%-90%	0.75	75%
90%	0.75	75%
91%	0.8	80%
92%	0.8	80%
93%	0.88	88%
94%	0.9	90%
95%	0.9	90%
96%	0.99	99%
97%	0.98	98%
98%	0.98	98%
99%	0.95	95%
100%	0	0%

Table: 3 represents the times of accuracies from the testing phase in this Application. Application couldn't get the 100% accuracy for any of the snakes.

Below Figure: 5 and Figure: 6 represent the first testing phase of this mobile Application. First attempt had lower accuracy since training data set not enough. After training the model with more images Application got better accuracy.

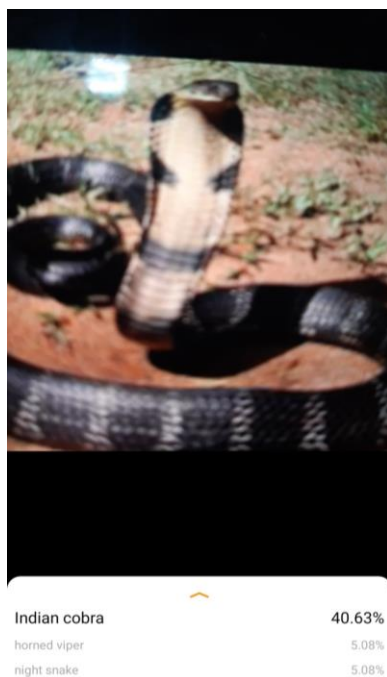


Figure 3: First Testing Attempt

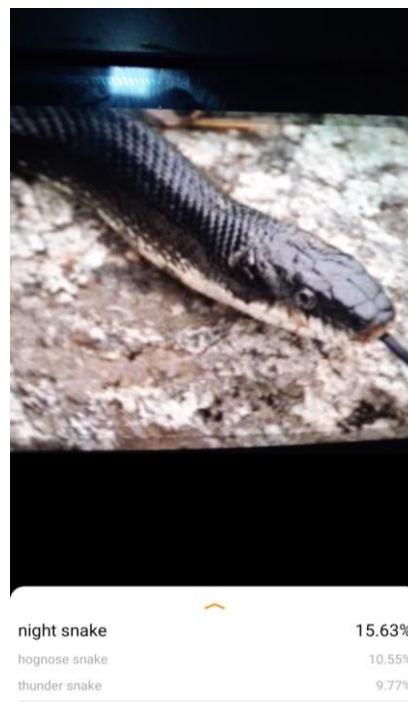


Figure 4: Second Testing Attempt

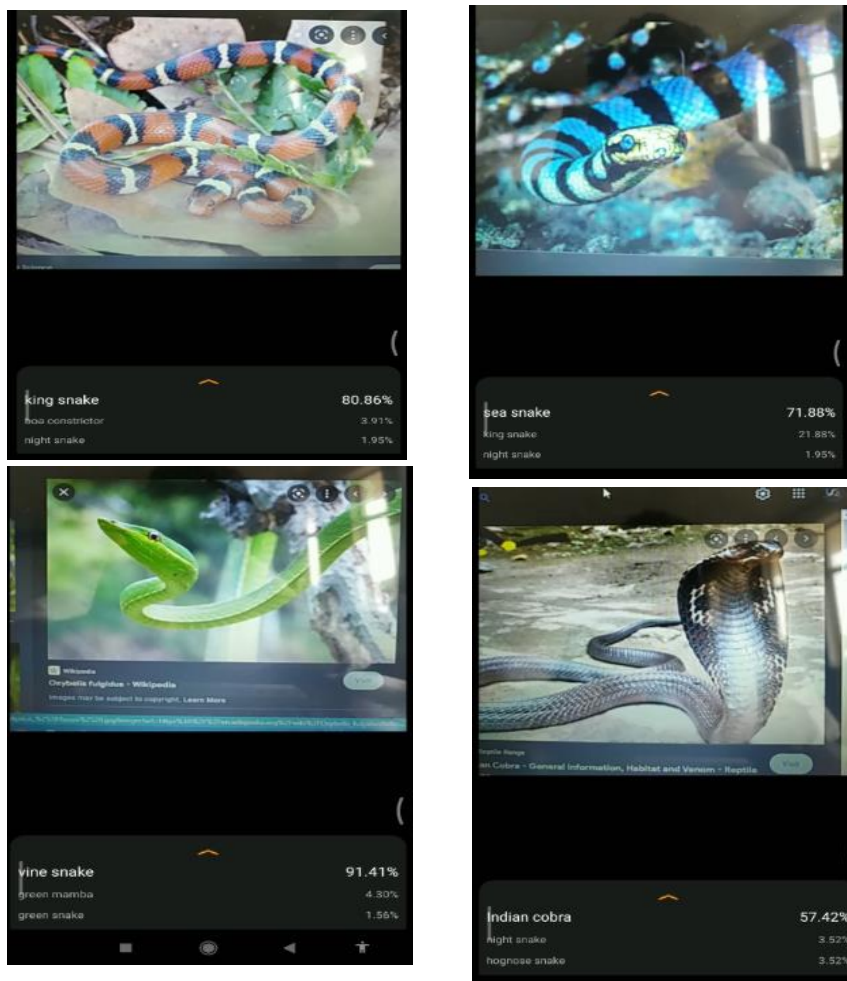


Figure 5: More Testing Attempts and Accuracy

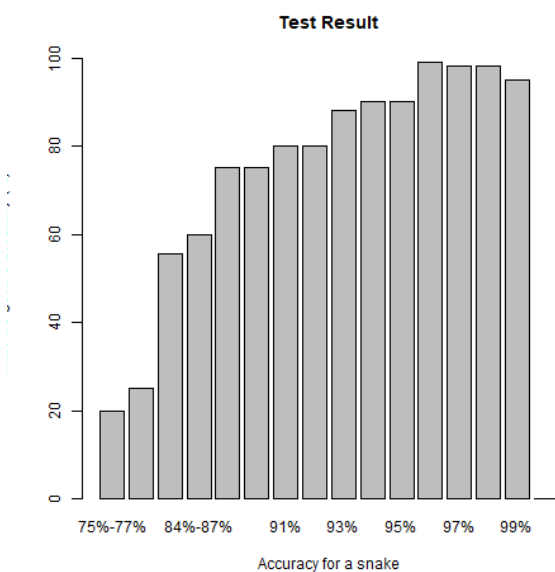


Figure 6: Bar Chart for Testing Result

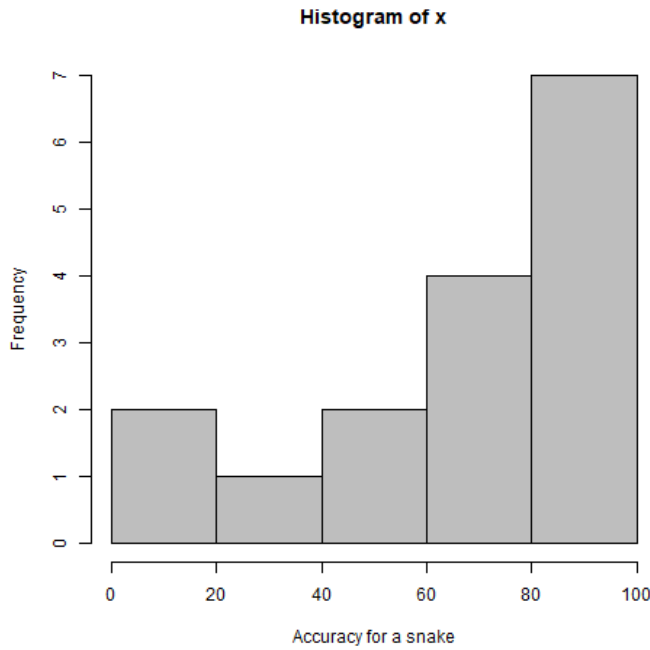


Figure 7: Histogram for Testing Results

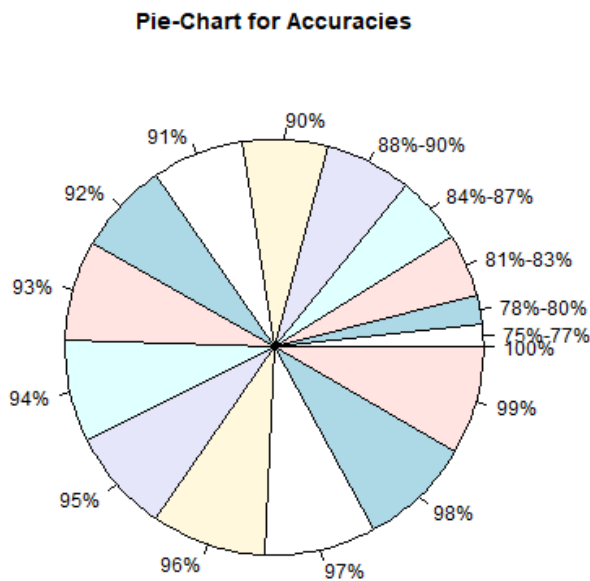


Figure 8: Pie Chart for Testing Results

Discussion

This research project succeeded in implementing a model in recognizing snake species based on image data, though there is room for improvement. The following are some of the challenges faced by this project:

1. Image dataset was limited. There were not enough images available for each species to train the model. 1500 images to train a deep learning model is not enough to achieve good accuracy. Image data augmentation could be a remedy in this case, though it requires additional deep-domain skills in deep learning, image processing, and computer vision. Image data augmentation would allow us to significantly

increase the data set size and diversity of images, providing the options of image modification by turning, flipping, padding, cropping, brightening, or darkening the object and background in the image.

2. There were a few images with complex backgrounds in which separating the snake from its surroundings was difficult. To resolve this issue, removing the backgrounds in images would significantly improve the results; however, the solution to automate the background removal for hundreds of thousands of images would have to be provided.

Project was started on 28/02/2022 and completed it on 07/04/2022. After completing the Mobile Application and the report of this project, additionally demonstration for the Mobile Application was done by the team.

There is much research that is related to image identification and machine learning. For the literature review more than 20 research papers were studied and most of the researches got the accuracy only with the internet. And there was no proper research that can identify snakes in real time without internet connection. This research gap is completed by this research.

Conclusion and Recommendations

Image recognition is currently using both AI and classical deep learning approaches therefore that it can compare different images to each other or its repository for specific attributes such as color and scale. AI-based systems have also started to outperform computers that are trained on less detailed knowledge of a subject. These days the majority of people have smartphones, therefore, people can instantly use the “Click Snake Android Application” to identify snakes from their smartphones conveniently. And it will save human lives as well as snakes. Click snake is the 1st step that tells the world, even a simple Mobile Application that is cost-effective can be useful to save lives and protect the environment. These future enhancements for the new version of this App will contain 5 more common snakes Ceylon Krait, Wart snake, Sand boa, Indian rock python, and Green vine snake. Increase the accuracy of the results, Develop the app with more user-friendly features for users like changing language settings, changing font size, and using the app without registering. Display the identified snake’s name with a brief description and first-aid if the user got a bite, Display the venomousness of snakes to get a notion immediately. (Using scale, meters, etc.) Creating a repository using the data that users are collecting by identifying the snakes and locations can be used to protect these important creatures. This can lead to creation the biggest database related to snakes or more indigenous animals in Sri Lanka.

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WEB-BASED SOLUTION FOR TESTING STUDENT PERFORMANCES WHILE FORECASTING STUDENTS' MARKS USING MACHINE LEARNING

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Abstract

This research is presented as a solution to the problem that Sri Lankan "O/L students" do not have a website or software to check their standards and there is no way to predict the scores obtained by G.C.E O/L students. In this study, a web application was developed to check the academic level of students appearing for G.C.E O/L in Sri Lanka and to predict the marks obtained by O/L students in science and mathematics subjects using a machine learning approach. Furthermore, predictions are based on the selected educational criteria of the students. Testing shows, that the above-mentioned student marks prediction works with 95% accuracy.

Keywords: E-Learning, Exams, G.C.E O/L, Machine Learning (ML), Prediction

Introduction

Background of the Study

The traditional methods of studying include doing papers manually and later getting them checked by a tutor or someone qualified enough. More up-to-date and interactive methods may help students in finding the help they need. There may arise different issues regarding this matter and solutions can be provided for them. (Halil Dundar, 2017)

There is a major economic crisis in Sri Lanka, mainly due to Corona. In times like these, many parents and guardians have neglected their children's education because they don't have enough income to provide the necessary facilities. At present, the development of female students has been greatly reduced due to these facts. Studies conducted during the Covid-19 period have shown that 22.1% of 15- to 16-year-old children drop out of school due to financial problems and 36.6% drop out due to a lack of interest in schoolwork. Children in rural areas are the most affected. Urban students generally had an advantage because of better teachers and resources. Now students in rural areas do not have access to any additional educational resources. (Nanayakkara, 2021) (halyk, 2022)

As a practical solution to overcome these problems, a self-help Web-based solution accessible to O/L students was created. This allows students to access and learn. It contains a machine learning method to predict the marks of students appearing in the G.C.E O/L Examination.

Objectives

- To predict the scores students will get in the o/l exam. That way they can check whether the current plan can achieve the desired result.
- Students can track their progress. Then you can get a clear understanding of their weak areas.

Literature Review

Through research on the web-based application for educational purposes, there were some websites with similar features to those on the proposed website. Also, there are identical features like student marks forecasting, student feedback, checking students' progress, etc. Literary articles containing information regarding these similar systems have been selected according to their significance. Mainly, articles that mentioned e-learning systems created including an artificial intelligence model were selected to be more significant than other sources. Hamsa, et al. (2016) and Kotsiantis, et al. (2004) reports that their studies used machine learning models such as decision tree classifier, fuzzy genetic algorithm, Naïve Bayes algorithm and instance based learning algorithms to create a prediction model for student performance. Sravani and Bala (2020) discusses how linear regression models are used for predicting student performance. Similar literature were personally reviewed and their methodologies were analyzed and evaluated before considering them to be included in this study as well.

Methodology

The data set used for this study was created from a database of Techno Lanka Institute in Sri Lanka. The data set contains 400 records, consisting of the data of the students who appeared for the O/L examination in the year 2021. All the features in the dataset are shown below.

	Student_ins_ID	First_Name	Last_Name	Birthday	Gender	Telephone_number	Email	Subject	Class_Activity_marks_1	Class_Activity_marks_2	Class_Activity_marks_3
0	STD_200	Piyumi	Prasadi	9/14/2002	Female	714595468	piyumi20@gmail.com	Science	50	52	57
1	STD_201	Sachithra	Devshan	5/10/2002	Male	716548958	Devshan@gmail.com	Science	55	59	54
2	STD_202	Shalom	Peries	1/4/2002	Male	774592452	Shalom@yahoo.com	Science	69	65	71
3	STD_203	Sanuji	Fernando	4/15/2002	Female	774581452	Sanujifernando@gmail.com	Science	60	61	58
4	STD_204	Pansilu	Perera	7/9/2002	Male	112256984	Pansilu0@gmail.com	Science	32	38	40

Figure 1: Dataset features 1

As shown in this study, Student_ins_ID, First_Name, Last_Name, Birthday, Gender, Telephone_number, and Email are some of the essential dropout features. They have no discernible effect on the final marks expected to be predicted. In the study, the attributes of the subject, gender, class activity marks 1, class activity marks 2, class activity marks 3, class activity marks 4, term test marks, and study hours were used to predict students' final marks accurately.

Class_Activity_marks_4	School_first_term_marks	School_second_term_marks	School_third_term_marks	Study_hours	Final_result
60	44	48	49	59	57
63	53	55	60	59	60
70	72	75	70	62	69
65	59	61	55	70	60
36	37	40	35	25	37

Figure 2: Dataset features 1

It was clear from the study that the subject, gender, class activity marks 1, class activity marks 2, class activity marks 3, class activity marks 4, term test marks, and study hours are the factors that affect the mark a student gets in the o/l exam. Class activity marks are the marks of 4 exams conducted after the third-semester exam. Term test marks are marks obtained by students in the first, second and third term examinations. "Study hours" means the number of hours the student has studied the subject in the third term.

As per the literature reviewed, three prediction models were chosen to be trained and analyzed according to the prediction accuracy: decision tree, lasso model and linear regression. All three models were similarly trained and tested with the same criteria and data.

The variables (attributes) used are presented in Table 1 along with the values of each attribute.

Table 1: The Attributes Used and Their Values

Subject	Maths ,Bio
Gender	Male , Female
Class activity marks 1	1-100
Class activity marks 2	1-100
Class activity marks 3	1-100
Class activity marks 4	1-100
First term test marks	1-100
Second term test marks	1-100
Third term test marks	1-100
Study hours	the number of hours the student has studied the subject in the third term
Final marks	Number of predicted marks

Finally, ``Final Score" (the dependent variable) predicts the subject-related score in the G.C.E O/L final exam with a value ranging from 1-100.

The accuracy is evaluated using ten-fold cross-validation which our dataset is partitioned into 0.8 for the training set and 0.2 for the testing set on the same dataset.

Figure 3 illustrates the flowchart of the proposed multiclass prediction model applied in this study.

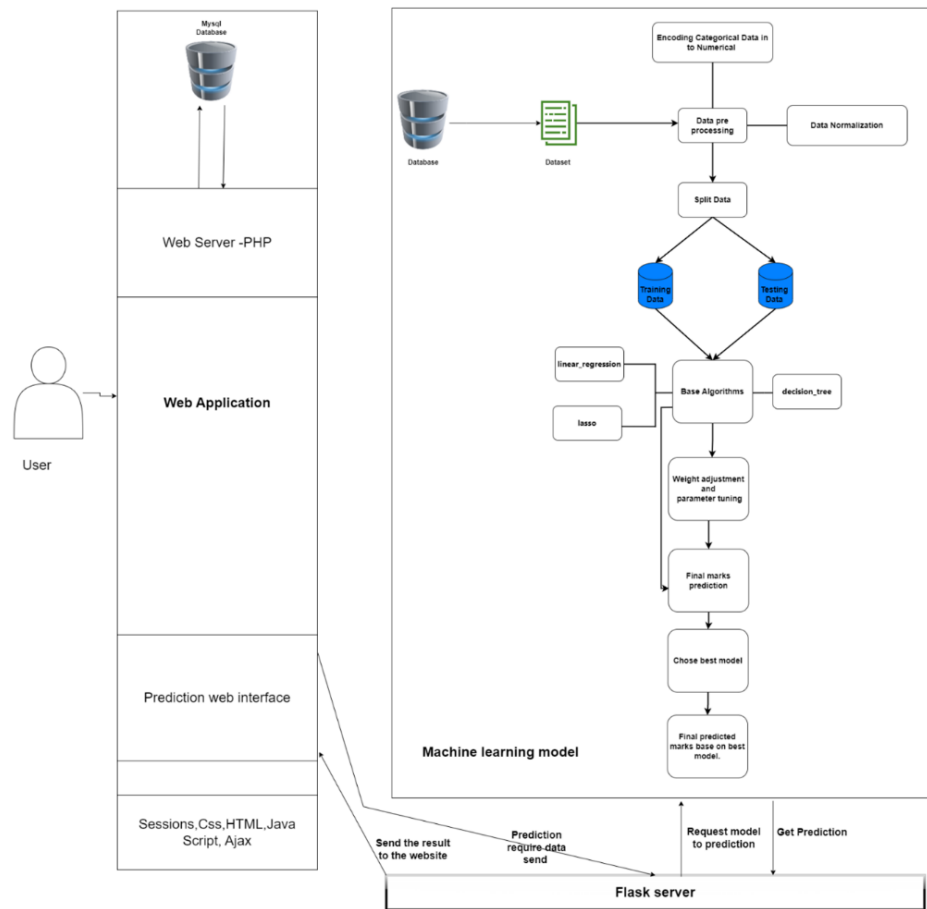


Figure 3: flowchart of the proposed M.L solution

Results

The data set should be checked during the pre-processing to determine whether it is balanced. (Kotsiantis, 2005) Here the researcher looked for whether it is balanced or not according to the difference in the number of males and females. It was revealed that there was no significant difference between male and female students.

Figure 5 shows that there is no significant difference between males and females.

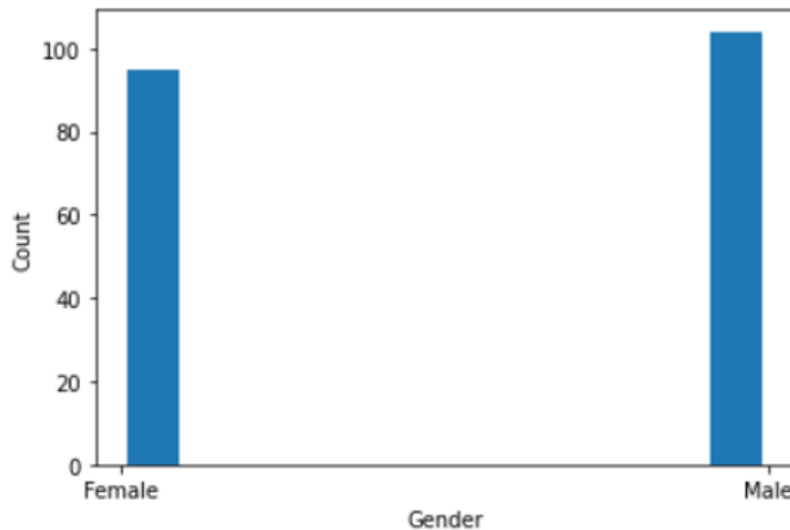


Figure 4: no significant difference between males and females

Then the data conversion process was carried out. In that process, the categorical data is converted into numerical form.

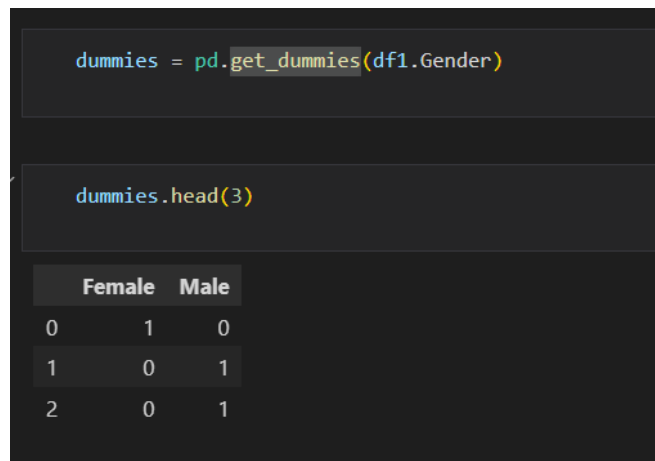


Figure 5: categorical data is converted into numerical form

Here the algorithm that gives the best performance should be chosen. For that, the algorithm should be checked first. Train and test by dividing the data into training and testing. The splitting is doing by randomly. The accuracy changes each time the code is run. Because of this, it is difficult to choose the best algorithm.

This problem can be easily overcome by using cross-validation. Here the data set is divided into ten parts. One part is used for testing, and the other part is used for training. After training, accuracy is sought using test data. Thus, the accuracy of all the pieces is searched separately by switching the test part. Finally, we can get the accuracy as a mean value. (Berrar, 2018)

By using the "GridSearchCV" technique can easily find the most suitable combination of parameters for the model being created. By using the most suitable combination of parameters, the highest accuracy can be obtained for the model. (Siji George C.G, 2020)


```
from sklearn.model_selection import GridSearchCV
from sklearn.linear_model import Lasso
from sklearn.tree import DecisionTreeRegressor

def find_best_model_using_gridsearchcv(X,y):
    algos = {
        'linear_regression' : {
            'model': LinearRegression(),
            'params': {
                'normalize': [True, False]
            }
        },
        'lasso': {
            'model': Lasso(),
            'params': {
                'alpha': [1,2],
                'selection': ['random', 'cyclic']
            }
        },
        'decision_tree': {
            'model': DecisionTreeRegressor(),
            'params': {
                'criterion' : ['mse', 'friedman_mse'],
                'splitter': ['best', 'random']
            }
        }
    }

    scores = []
    cv = ShuffleSplit(n_splits=10, test_size=0.2, random_state=0)
    for algo_name, config in algos.items():
        gs = GridSearchCV(config['model'], config['params'], cv=cv, return_train_score=False)
        gs.fit(X,y)
        scores.append({
            'model': algo_name,
            'best_score': gs.best_score_,
            'best_params': gs.best_params_
        })

    return pd.DataFrame(scores,columns=['model','best_score','best_params'])

find_best_model_using_gridsearchcv(X,y)
```

✓ 0.4s

Figure 6: Find best model

Here the "find_best_model_using_gridsearchcv" function was created to find the best model. Then x and y parameters were given as values. Here, "LinearRegression," "Lasso," and "DecisionTreeRegressor" were used to find the best model. Separate parameters were assigned to find the best parameters.

Then, using a "for" loop, the best algorithm, and the most suitable parameters were determined. "Ten-fold cross-validation" was used here. "return_train_score=False" is given as only the test score is required. After an array was created and named as a "score," the model name, accuracy score, and most suitable parameters were saved.

Table 2: Error margins and accuracy for prediction in Science

	Lasso	Decision Tree	Linear Regression
Error margins			
MAE	2.23	1.70	2.25
RMSE	3.19	2.88	3.14
Accuracy			
R2 Train	96.47	96.77	96.48
R2 Test	93.22	94.73	93.21

The above table shows the error margins and the accuracy based off R2 values of science. Decision tree regression model has the lowest mean absolute error (MAE) and root mean squared error (RMSE) as well. Highest accuracy is also shown in decision tree regression model.

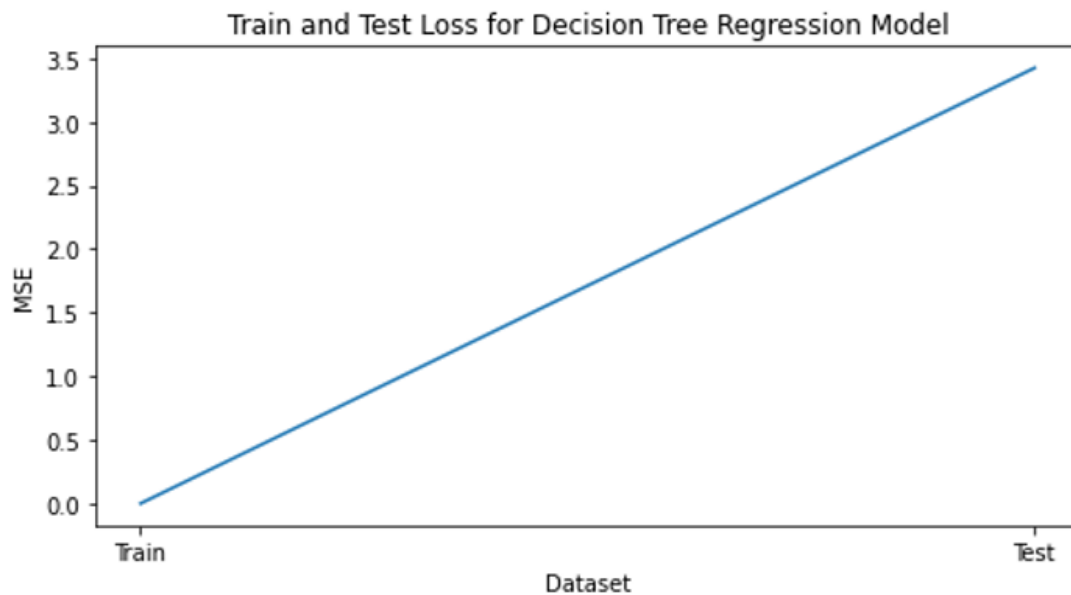


Figure 7: Train and test loss for decision tree regression model

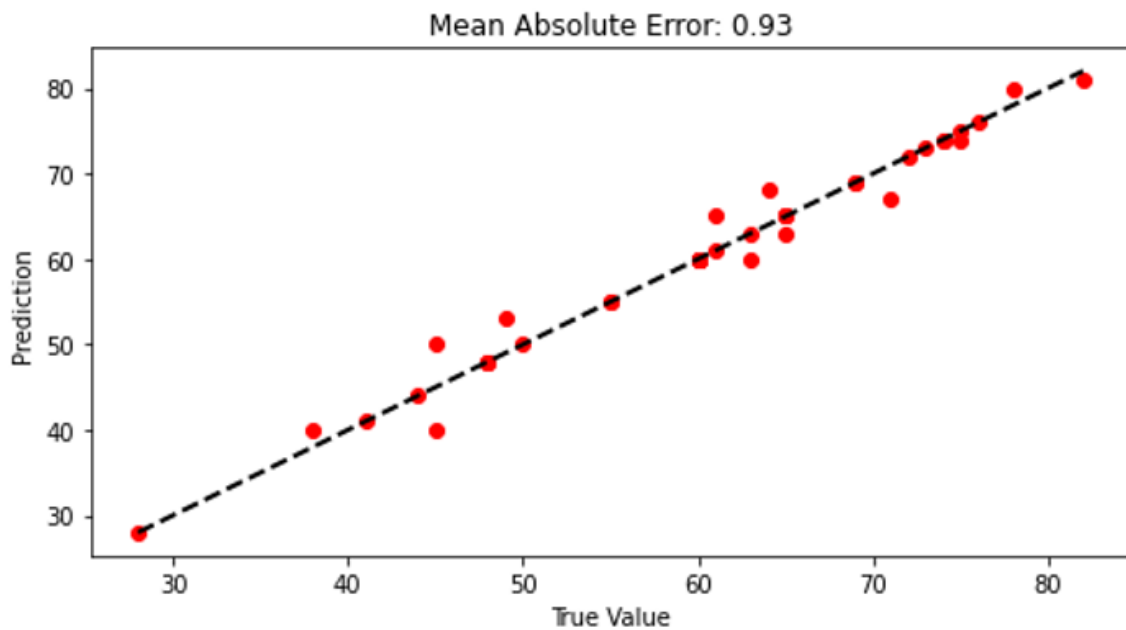


Figure 8: Mean absolute value calculated related to decision tree

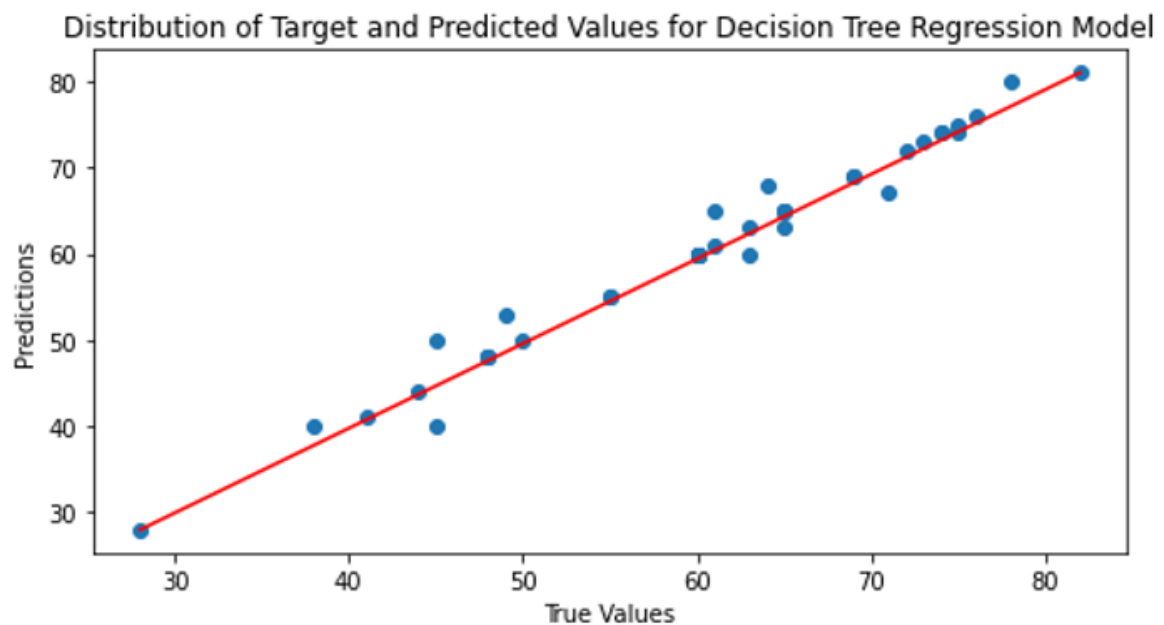


Figure 9: Distribution of Target and Predicted Values for Decision Tree Regression Model

All above graphs are related to the scores predicted by the decision tree regression model for the science subject.

Table 3: Error margins and accuracy for prediction in maths

	Lasso	Decision Tree	Linear Regression
Error margins			
MAE	2.04	0.93	2.14
RMSE	2.58	1.910	2.75
Accuracy			
R2 Train	96.14	98.23	96.17
R2 Test	95.19	97.65	94.88

Similar to the predictions of science marks, maths predictions were also most accurate in decision tree regression model when MAE, RMSE and R2 values were evaluated in all the models used.



Figure 10: Train and test loss for decision tree regression model

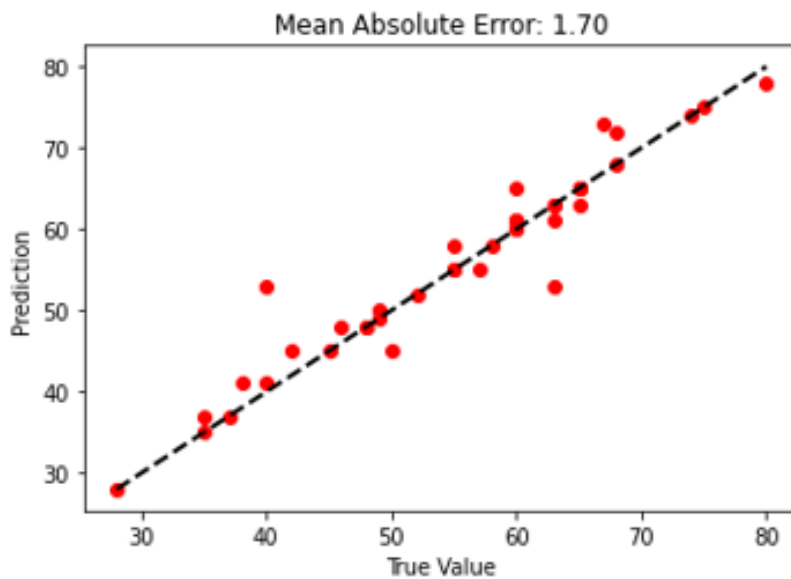


Figure 11: Mean absolute error related to desicion tree in Maths

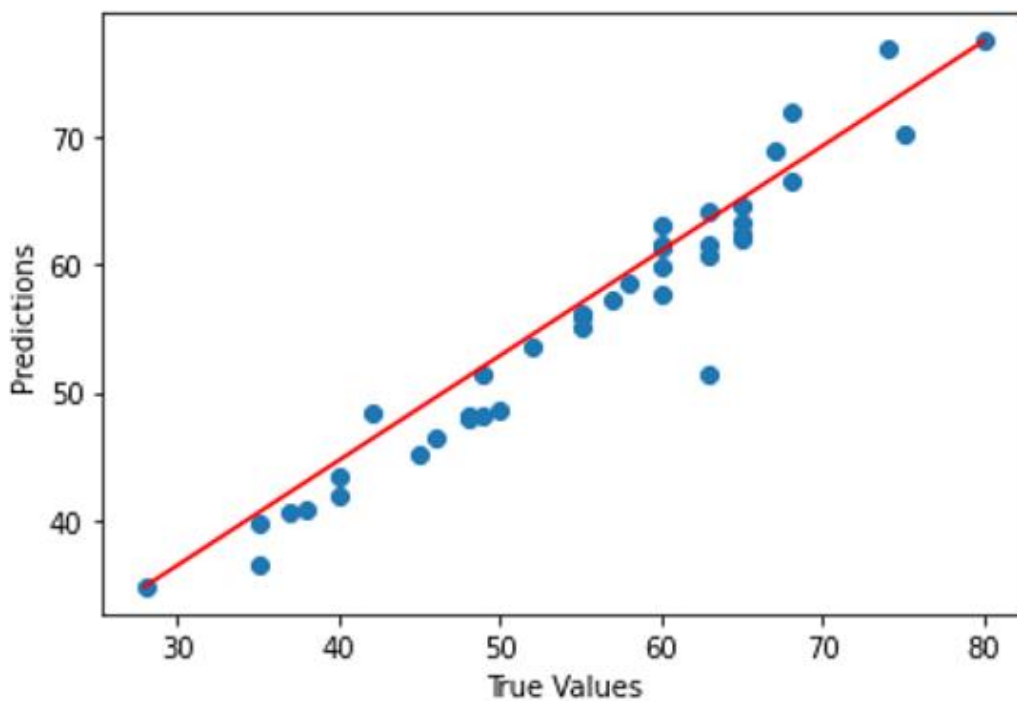


Figure 12: Distribution of Target and Predicted Values for Decision Tree Regression Model

The graphs related to decision tree regression model predictions are evident that this model is the most appropriate model to be used in this prediction.

Discussion

According to the results of the research, it is clear that for both mathematics and science subjects the decision tree prediction model is the most accurate. Decision tree predicted the scores with an accuracy of 95% related to science subject while the accuracy of prediction

increased in the mathematics section up to 97%. Similar systems related to the proposed research contained some limitations, which were successfully overcome to an extent. Barrack (2016) states that lack of experimental techniques for prediction was a limitation for the study. The proposed system had no such limitation as three models were used and the most accurate and effective model was chosen amongst them. The models were trained and tested using datasets which returned positive results. Abana (2019) also reports the same limitation during a study regarding decision tree model for predicting student grades. Anderson (2017) reports that a dataset limitation occurred during research. The above research had a complete dataset with every data criterion included properly and accurately.

Conclusion

One of the main problems faced by G.C.E O/L students in Sri Lanka is the lack of a method to check their level of education by providing answers to subject questions using a web application and the lack of a method to predict their student marks. The above research contains the final report of the system developed by the researcher to create a system for checking the academic level of students appearing for the General Level Examination in Sri Lanka and a system for predicting student scores. Based on the selected educational data of the students, the researcher has been able to create a method for predicting the marks that the students will get and a method for the students to answer the questions to check their educational level. The final outcomes of the research showed that according to the given dataset, the most accurate prediction model is the decision tree.

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STUDY ON CHALLENGES OF DEVOPS ADOPTATION IN SRI LANKAN SOFTWARE DEVELOPMENT COMPANIES

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Abstract

DevOps is a collection of practices, tools and a traditional philosophy which automate and combine the processes between software development and IT operations teams. This encourages team empowerment, team communication cross-team communication and collaboration, and technology automation. This research is mainly focused on challenges which face by software development firms while adopting to DevOps practices within Sri Lanka. Researchers have given an effort to identify common type of challenges related to DevOps adaptation which have been found through previous studies. As the next step, how those identified challenges make an impact on Sri Lankan software development process have been discussed by the researchers by using both quantitative and qualitative mixed type of approaches. After the analysis of questionnaire survey data, researchers could be able to realize that some of the challenges which have been identified by the previous researchers may effect on Sri Lankan software development industry and according to the analysis of interviewed data, another set of challenges have been identified by the researchers.

Keywords: Continuous Delivery (CD), Continuous Integration DevOps practices, Systematic Literature Review (SLR)

Introduction

The term “DevOps” is a portmanteau of two terms call development and operations. This development approach will allow both developers and operations related technical people to work in closely manner. As one of the main goals of introducing this concept, enhancing the communication and combining of both development and operations in order to achieve high benefits with use of modern day software development approaches. (DevOps in Practice: A Multiple Case Study of Five Companies , 2019)

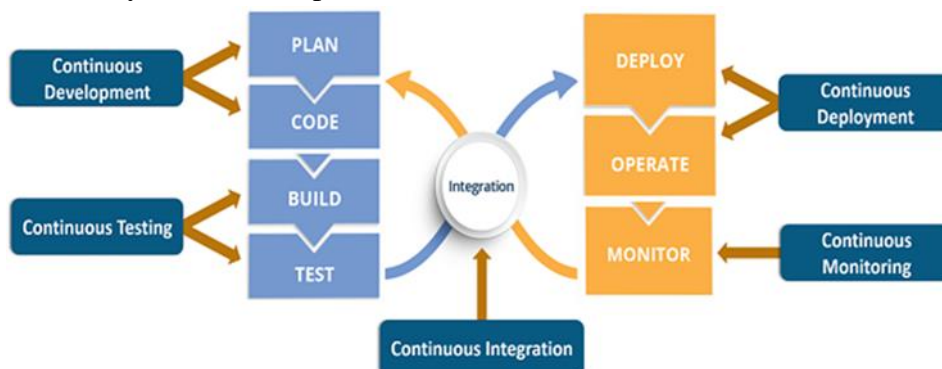


Figure 1: DevOps phases

As described by AWS (Amazon Web Services), while working under a DevOps model, the development and operations teams are no longer functioning according to “siloe” manner. Moreover, they have stated, sometimes these two teams can be merged into a single team

where engineers involve within the entire software development life cycle. Within some DevOps model, can be seen an integration between Software Quality Assurance (SQA) and Security teams along with development and operations teams throughout the application life cycle. This can be highlighted when security is highly focused component by everyone on the DevOps team. This is also known as “DevSecOps”. (AWS, 2022)

Significance of The Study

According to ICTA, it said that IT industry in Sri Lanka is about to reach USD 3 billion revenue by 2021. Furthermore, stated Sri Lanka could be able to increase the rank up to 85th globally in year 2020 within e-Government Development Index. Sri Lanka was in 94th in year 2018. (ICTA, 2021) Another source has stated been stated that both ICT and Business process outsourcing sector in Sri Lanka have been tripled exports as well as doubled the workforce in between 2015 – 2020-time period. Sri Lanka is also developing as a global IT Business Process Outsourcing (BPO) destination of choice in numerous key areas. Sri Lanka’s software development industry has grown expressively during the years. It includes telecommunications, banking, financial services, and insurance (BFSI) and software testing. (TRADE, 2022) Moreover it can be seen that majority of young crowd tend to continue their higher studies related to IT. Because of this facts can expect that, IT sector in Sri Lanka will achieve more within the global context. Therefore it is essential to have a look on Sri Lankan IT industry, especially by considering the current practices, the tools which use at the moment and etc.

Table 1: Summary of the Literature

Variable	Source
Collaboration and Communication	Khan, M. S. et al. (2022) Anandya, R., Raharjo, T. and Suhanto, A. (2021) Jayakody, J. A. V. M. K. and Wijayanayake, W. M. J. I. (2021) ShoaibMS-IEEE-Access-21.pdf Erich, F. M. A., Amrit, C. and Daneva, M. (2017) Noorani, N. et al. (2022) Diel, E., Marczak, S. and Cruzes, D. S. (2016) Krey, M. (2022)
Skill	Khan, M. S. et al. (2022) Anandya, R., Raharjo, T. and Suhanto, A. (2021) Jayakody, J. A. V. M. K. and Wijayanayake, W. M. J. I. (2021) Erich, F. M. A., Amrit, C. and Daneva, M. (2017) Senapathi, M., Buchan, J. and Osman, H.

	(2018) Noorani, N. et al. (2022) Shameem, M. (2022) Alenezi, M. (2022) Bucena, I. and Kirikova, M., 2017,
Tools / Technologies	Khan, M. S. et al. (2022) Shameem, M. (2022) Ghantous, G. and Gill, A. (2017) Alenezi, M. (2022) Noorani, N. et al. (2022) Ghantous, G. and Gill, A. (2017) Joby, Dr (2019)
Experience level of the firm	Khan, M. S. et al. (2022) Anandya, R., Raharjo, T. and Suhanto, A. (2021) Jayakody, J. A. V. M. K. and Wijayanayake, W. M. J. I. (2021) Noorani, N. et al. (2022) Alenezi, M. (2022) Bucena, I. and Kirikova, M., 2017

Based on the SLR and the assumptions, the developed conceptual framework by the researchers is given below.

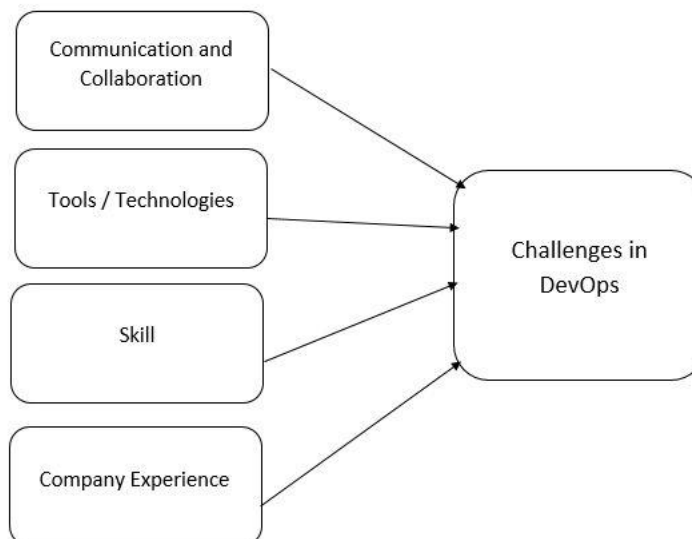


Figure 2: Conceptual Framework

Research Questions

RQ1. What is the Definition of DevOps?

RQ2. What are the challenges occurring in adopting DevOps practices?

Development of Hypothesis

Hypothesis 01

Identify the relationship between communication/collaboration and Challenges in DevOps practices.

- | |
|--|
| H1 ₀ – Communication/collaboration does not have a relationship with challenges in DevOps practices.
H1 _a – Communication/collaboration has a relationship with challenges in DevOps practices. |
|--|

Hypothesis 02

Identify the relationship between tools/technologies and challenges in DevOps practices.

- | |
|--|
| H2 ₀ – Tools/Technologies does not have a relationship with challenges in DevOps practices.
H2 _a – Tools/Technologies has a relationship with challenges in DevOps practices. |
|--|

Hypothesis 03

Identify the relationship between DevOps practitioner's skill and challenges in DevOps practices.

- | |
|--|
| H3 ₀ – Skill does not have a relationship with challenges in DevOps practices.
H3 _a – Skill has a relationship with challenges in DevOps practices. |
|--|

Hypothesis 04

Identify the relationship between Software Development Company's experience level and challenges in DevOps practices.

- | |
|--|
| H4 ₀ – company's experience level does not have a relationship with challenges in DevOps practices.
H4 _a – Company's experience level has a relationship with challenges in DevOps practices. |
|--|

Methodology

The main aim of this study is to identify the challenges face by software development firms while adopting DevOps practices within Sri Lankan context.

Both qualitative and quantitative approaches have been applied by the researchers in order to extract the desired data. A Systematic Literature Review (SLR) and questionnaire survey study and an interview study were followed to identify the challenges for adopting the DevOps approach in software development disciplinary in Sri Lanka. (Fernandes et al., 2022), (Jayakodi et al., 2021)

Questionnaire Survey

In here, the intended data collection method was quantitative. Therefore close-ended type of an e questionnaire has been shared by the researchers with the selected audience. Correlation analysis method has been used by the researchers for the analysis of data in order to identify the relationship with Dependent Variable and Independent Variables. Population for the research represents Information Technology (IT) professionals those who are directly involving within DevOps practices that because of their having an idea with regarding the tools, processes, methodologies which use in software development. As planned, researchers have emailed shared the prepared questionnaire with 100 DevOps practitioners via emails.

Interview

A semi-structured interview was used in this study to collect data to develop an understanding of the challenges that they faced in practical environment.


Seven interviewees who held the position of Senior DevOps engineers were being selected from software development disciplinary. Selection was done through personal contact.

All of them had time constraints to schedule a meeting anyway managed to schedule meetings based on their convenient time. Interviews were conducted and recorded by using mobile phones with the permission of interviewees. Time duration of an interview was around 30 minutes.

The interview starts with explaining the aim of the research. Different questions were formulated to collect the respondents' ideas about DevOps adoption related challenges. The questions were Open-ended questions to give the freedom to the respondents to express their views freely. Those questions were followed up by some informal sessions to clarify and refine issues as they emerged.

The companies which have been interviewed by the researchers are being replaced by using anonymous names.

Table 2: Interview Summary



Organization	Type	Description	Position
Com1	Large scale International company. Project development team.	global business consulting and IT outsourcing	Senior DevOps engineer.
Com2	Small scale With 400 to 500 employees. In house development team Education institute.	Understanding the internal requirements design and develop different types of projects.HR system, Procurement ,payments	Senior software engineer.
Com3	Small scale With 50 to 60 employees. IT support and services team	IT support and service provider	Senior DevOps engineer.
Com4	Medium scale Software development company	IT solution provider	Senior DevOps engineer.
Com5	In house development team Large scale Private bank in sri lanka	Various types of financial applications. Build automation for manual processes. Developing extensions for an existing application	Senior DevOps engineer.
Com6	Medium scale Software development company	HR, Payroll solutions	Senior DevOps engineer.

The interview questions which have been asked from the seven DevOps engineers are given below;

1. Could you please state your background - your name, role, and work experience?
2. Could you give brief description about your organization-type, number of employees, projects
3. What does DevOps mean to you and your organization?
4. What are the challenges of adopting DevOps practices?
5. Which of those challenges are you able to successfully solve?
6. What kind of support is needed to solve these challenges?
7. Do the Developers or Operators face any challenges related to the tools they use?
8. What are those challenges?
9. How did you recruit people?
10. Any other comments you would like to add?
11. What problems did the organization encounter when implementing DevOps? |

Figure 3: Interview Questions

Results and Discussion

Results Interpretation of Questionnaire Survey

IBM SPSS Statistics software package is used to analyze the data. Correlation and coefficient analysis approach is used to evaluate the linear relationship between the dependent variable and the five independent variables selected. Further, Analysis results have been visualized in graphical format to emphasize the statistically significant features. The following diagram shows all the variables defined within SPSS application.

In order to find out the relationships between independent and dependent variables, researchers have applied Pearson Correlation. The following tables show the results which have been obtained after the analysis done by the SPSS application.

Correlation between Company Experience Level and DevOps Challenges

Table 3: Correlation between Company Experience Level and DevOps Challenges

Correlations			
		AvgCompany Exp	AvgChallenge s
AvgCompanyExp	Pearson Correlation	1	.950**
	Sig. (2-tailed)		.000
	N	51	51
AvgChallenges	Pearson Correlation	.950**	1
	Sig. (2-tailed)	.000	
	N	51	51

The generated correlation coefficient value is 0.950. It implies that there is a strong positive relationship between the independent variable company experience level and the dependent variable, challenges in DevOps practices. Moreover Sig. value of 0.000 which is lesser than 0.05 indicates that is possible to reject the null hypothesis.

Correlation between Tools/ Technologies and DevOps Challenges

Table 4: Correlation between Tools/ Technologies and DevOps Challenges

Correlations			
		AvgChallenge s	AvgTools
AvgChallenges	Pearson Correlation	1	.403**
	Sig. (2-tailed)		.003
	N	51	51
AvgTools	Pearson Correlation	.403**	1
	Sig. (2-tailed)	.003	
	N	51	51

The generated correlation coefficient value is 0.403. It implies that there is a moderate level of a positive relationship between the independent variable tools/technologies and the dependent variable, challenges in DevOps practices. Moreover Sig. value of 0.003 which is lesser than 0.05 indicates that is possible to reject the null hypothesis.

Correlation between Communication/Collaboration and DevOps Challenges

Table 5: Correlation between Communication/Collaboration and DevOps Challenges

Correlations			
		AvgChallenges	AvgCommunication
AvgChallenges	Pearson Correlation	1	-.312 [*]
	Sig. (2-tailed)		.026
	N	51	51
AvgCommunication	Pearson Correlation	-.312 [*]	1
	Sig. (2-tailed)	.026	
	N	51	51

The generated correlation coefficient value is -0.312. It implies that there is a weak level of a negative relationship between the independent variable communication/collaboration and the dependent variable, challenges in DevOps practices. Moreover Sig. value of 0.026 which is higher than 0.05 indicates there is no enough evidence to reject the null hypothesis.

Correlation between DevOps Practitioner's skill and DevOps Challenges

Table 6: Correlation between DevOps Practitioner's skill and DevOps Challenges

Correlations			
		AvgChallenges	Skill
AvgChallenges	Pearson Correlation	1	.362 ^{**}
	Sig. (2-tailed)		.009
	N	51	51
Skill	Pearson Correlation	.362 ^{**}	1
	Sig. (2-tailed)	.009	
	N	51	51

The generated correlation coefficient value is 0.362. It implies that there is a weak level of a positive relationship between the independent variable DevOps practitioner's skill and the dependent variable, challenges in DevOps practices. Moreover Sig. value of 0.009 which is lesser than 0.05 indicates that is possible to reject the null hypothesis.

Results Interpretation of the Semi-Structured Interview

Majority of interviewees have pointed out the followings as challenges which they have been encountered while adopting to DevOps practices.

“Finding people with required skills are very hard, Skills needed are missing at the time of need

to give training so meeting deadlines are difficult. One of the most common challenge is uncertainty of responsibilities. Software developers feel like handling operations are waste of

their time. (Example: User communication). It is a disadvantage for their carrier development.

Need to concentrate on several tools. Tools are varied with projects. Lack of setting realistic goals and timelines. Requested qualifications in the recruitment is not relevant with responsibilities.”

Discussion

It seems that some of the challenges which have been identified by foreign researches such like communication and collaboration, Experience level of the organization, Employee skill, tools/ technologies are making an impact within Sri Lankan software development industry as well. These things have been realized by the researchers through the quantitative analysis. In addition to that, through the qualitative approach researchers could be able to identify that, there are many different types of challenges also are existing within Sri Lankan context such like scope not properly defined which means when companies are hiring employees as DevOps engineers, it is not clearly defined up to which extent DevOps skills are required by an engineer. Moreover, majority of Software Engineers are having an impression like waste of time that because of Software Engineers may have to involve with operations as well. Also, there are wide range of tools and technologies can be seen within DevOps approach, another challenge DevOps engineers have pointed out is tools and technologies may change from project to project. Therefore, they may require more training programs in order to develop and enhance their skills.

Conclusion and Future Work

DevOps can be identified as portmanteau of two terms call development and operations. Development firms can speed up the delivery process of the product by using DevOps related practices.

However, when firms are adopting to DevOps practices, they may face for different types of challenges such like lack of communication / collaboration, lack of development firm's experience, not having much sufficient level of skills for DevOps practitioners, and scope of the responsibilities and the tools/ technologies are not clearly defined and etc. During the study these are the challenges could be able to identify by the researchers, however they have planned to continue this research in future by taking two different medium or large scale of software development firms (One company may use DevOps practices and the other one does not use DevOps) and making a comparison to determine which process is more effective in software development disciplinary. The future study has been planned to conduct by focusing more on qualitative analysis compared to the current study.

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IMPACT OF MEETING, ELEARNING APPS OR SOFTWARE FOR THE LEARNING CONTINUITY OF STUDENTS DURING PANDEMIC.

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Abstract

Education industry has been effected by different technological enhancements and significant application developments have created a trend within the society related to learning procedures. Aim of this study was to critically assess how different mobile Apps/software usage are affects for the learning continuity of students during disaster or pandemic. Due to the lack of relevant theoretical approaches, the study was conducted with inductive approach by collecting qualitative data. Identified population researcher selected 65 and going through the interview and with that discussion few infrastructure issues are identified and recommend to introduce few data plans by the ISP and connect with CEB Services.

Key words: Continuity of learning, Learning applications

Introduction

Disasters or pandemic can be recognized as emergencies which are occurring with natural environmental impacts. Furthermore, it can be observed at any country and it will affect for all level of age groups. When this affects everyone in this way, it can create a huge impact on those who have been engaged with the academic activities. Yet fortunately, the modern world has lot of facilities to control these conditions with the technological enhancements. For the education sector there having distance Learning and eLearning facilities. Also due to immense improvement on logical and physical resources in information technology, there are large range of application and software, which can drive eLearning into another dimension. The critical aspect which needed to recognize is that why the learning process is not yet smart although the relevant things are up to the level. As a solution for that, builds a new platform for this and it is known as mLearning which work with different applications. In the existing scenarios, the students having facilities and the services, but actually did they get the full use of these to continue their learning during above mention type of situation. This new technology trends can use to improve the education not only in the disaster time but also in normal time period as well. This eLearning or mLearning define in number of different ways and broadly describe as “instructional content or learning experience delivered or enabled by electronic technologies” (Ong, Lai and Wang, 2004. p1). Also when looking to this as simple definition, this can be like this, delivering study content using internet, intranet, extranet, using CD/DVD, and through broadcasting services both in radio and television. (Wagner, Head and Hassanein, 2008).

Although the schools and higher education institutes are using these applications during the Covid-19 pandemic situation, most of the teachers are coming up with negative feedback as the students are not actively participating with the lectures and not completing and continuing their studies effectively. (Hayashi et al., 2020) Due to the lack of empirical studies based on

this research phenomenon, researcher has conducted this study to achieve following research objectives.

Research objectives

- To investigate that why students are not using these apps.
- To examine why students are not getting the real benefits of these mobile learning/teaching apps.
- To determine the impact of factors related to the usage of software/apps on student's learning continuity.

Methodology

For this study qualitative data was collected through a survey based on interview which was developed to suite the nature and objective of the study. The target population of the study was to primary and secondary level students in Galle area. Out of the population, 65 of the students were selected as the sample of the study by using stratified sampling technique (as in below table). The interview was consisted of open-ended questions which covering up the following study areas. Each section having few sub questions which are used to collect interviewers' ideas clearer. Most of these discussion / interviews are conduct over telephone as a video call and they genuinely provide their feedbacks on these.

Study Framework

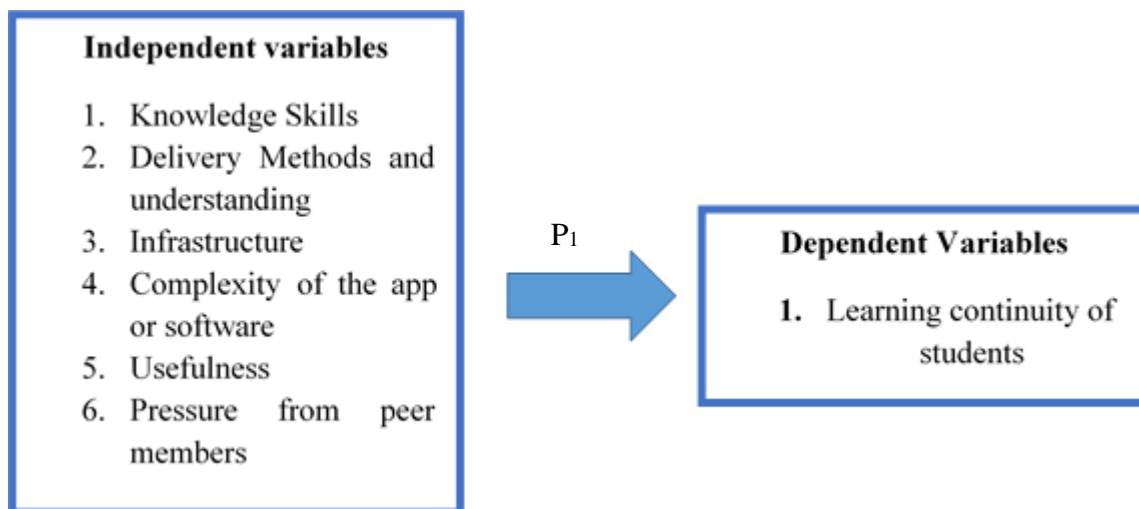


Figure 1: Study framework

Propositions

- P₁: There is a significant impact of factors related to the usage of software/apps on student's learning continuity.

Table 1: Age group categories

Group #	Age Group	Number of participants
1	16 years – 19 Years	11
2	20 Years – 25 Years	22
3	26 Years – 30 Years	15
4	31 Years – 35 Years	10
5	35 Years – 40 Years	7
	Total	65

Results and Discussion

As per the results of the study most of students use Microsoft Teams, Zoom and google meet for this learning sessions Also all they have fair enough knowledge regarding one of these tools. According to that MS-Teams used by 37% and 40% used Zoom as well this newly introduce Google Meet also used by 15%.

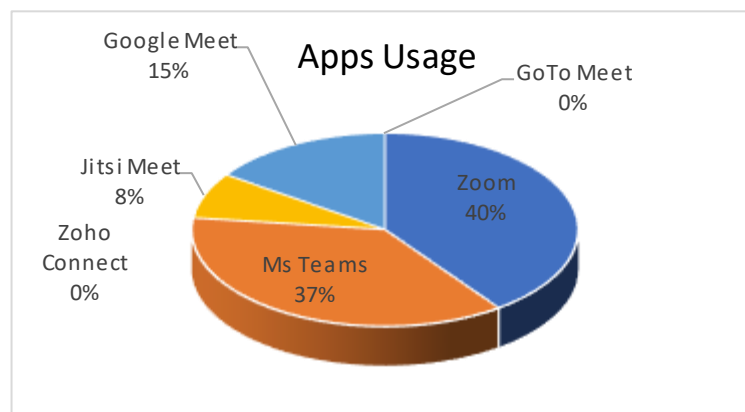


Figure 2: Apps usage

Most of interviewees had same kind of answers. As they have required enough knowledge of using internet most of the interviewees doesn't having much idea of using these tools. Initially when discuss with them, most of interviewees said lectures are not much feel in this online delivery due to this delivery problem especially in practical parts. But they are ready take the challenge and ready continue their learning by improving knowledge on this. In traditional method most of the time lecturers are used white board and also there is formal, informal discussion on the topic. But in this online method lecturer limit in to their presentations and sometime lectures are used onscreen white boards to draw things, this they pointing as a problem in this delivery.

Most of the students in each group like to have their classes at 8.00 AM to 1.00 PM time slot and then by after 5.00 PM to 11.00 PM time slot. Researcher then finds out the reason for why any specific time slots are preferred by the student to learn and why they not taking their

classes at the 12.00 noon to 6.00 PM session slot. For that most of the student's answer is they are not feel the class much at this time as they are studying alone.

Students' experience on data usage in different Apps was examined by researcher. Students stated Microsoft Teams and Jitsi Meet had the highest level of data usage. Most of the students are worried about internet service providers' problems. Also they pointing they don't have much ROI on this.

When researcher study about their data packages which they use for their online sessions, most of the students are used Dialog, Sri Lanka Telecom (SLT), Mobitel, and also very few students used LankaBell connection.

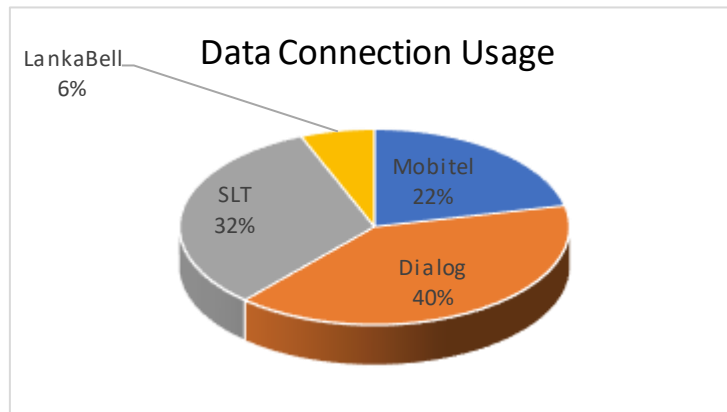


Figure 3: Data connection usage

The main problem that students had, who work with Zoom, is the time limitation in free edition. In Microsoft Teams' (MST) users in this research sample stated; that they experience frequent login problems to their account via all platforms. Other most important problem that students are raising, session recording issues. Students using MST and Zoom are stating that they feel clear live voice stream without any delay. Also at same time student can send a message to the lecturer by asking any question using the chat area. Other most interesting feature that students are pointing is desktop sharing feature.

Very few number of students are stated that, this online classes are not enhanced their interest in learning. But most of the students in the sample stated that, this method is enhanced their interest in learning during this situation. But with the practical modules there having some issues.

With the time pass, students those who have little experience on this meeting tool motivated others to use this tool to continue their learning, also researcher discussed with some educators, lecturers and they also stated “yes we motivated students to use this technology to continue their studies”.

In this research, researcher aimed to confirm the preposition that, impact of identified factors plays a crucial role in learning continuity of student during such disaster period. Complexity of these tools are not a big deal for most of the participants in each category as they state that they can easily deal with these tools without any fuzzy. Also, they stated without doing anything in such disaster period having a such a tool to study would be a really good chance to continue their learning and its really useful tool to have. At the same time participants propose to add some features to each tool. Addition to that although participant had some

data plans, they suggest to have proper data plans especially on these tools related protocols, also participants proposed to improve their coverage as well. Few are stated that peer members in the class support to understand the flow of delivery and work on tool.

Conclusion and Recommendation

The main purpose of this study was to find impact of factors related to the usage of software/apps on student's learning continuity during a disaster or pandemic. And researcher identified Then researcher would like to inform the research findings and recommendations for the local government schools, other education institutes and private universities etc.

By analyzing all above information researcher identify there having really big impact on these apps or software to continue this online education and it's really positive and on the good side. All the students are really like to use these tools for their studies during this kind of disaster or pandemic situation. At beginning all student were didn't like to use this apps/software for their studies and all are thought this not going to work, but when things are process students are really happy with the things and they accept this impact as good thing for their education and they would like to continue this method in a situation like this again.

Based on the study student in every group show required enough knowledge on internet use and computer use. As students had some problems and missed guidance at the beginning of this learning process, they are successfully rectified almost everything when the things are progressing. And students are happy about the delivery and they are understood what they learnt. Students are pointing few problems that they had with the internet service providers. Which are day time, night time data separation, FUP and some speed issues. As well some unplanned power cuts and devices' specification matters. Students are happy to buy a new computer or required devices if this online teaching is going to continue. Also they are happy to change their data connection for a new connection if it has good return on investment. Better to provide proper user friendly recording feature for each apps while upholding the lecturer privacy. Students are really happy to have such tools to study their courses during this kind of pandemic or disaster situation as they can continue their studies without any delays or any breakdowns. They are thoroughly accepted this method really useful for the theory modules bit of issue with the practical. Also they point another thing which is they don't want to travel here and there and that save their time and money also they safe at their home while they are studying. The last point the interview actually not directly affect for the matter but with that very few members form different categories motivated to attend for the lectures.

As per the above conclusions, researcher suggested to consider on relevant and appropriate internet service from provides with proper coverage and with special data packages for learning activities. Further, students can use relevant electricity provider's SMS service to get the prior notification about power cuts and then student can inform that in to their institute before the lecture schedule. (CEB, 2020) | (LECO Short Message Service, 2020)

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PROJECT MANAGEMENT

TELEWORKING; ITS IMPACT ON SOFTWARE PROJECT SUCCESS: A CASE STUDY-ABC PVT(LTD) IN THE NEW NORMAL

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Abstract

This research was to identify the factors which influence the software project under teleworking mode at ABC during the past pandemic. Due to the decline of the services, and engagement of ABC, this study tries to respond to the **What are the enabling and inhibiting factors for software project success under teleworking? What is the level of impact each of these factors has on software project success at ABC? To what extent these identified factors are present in favor of project success at ABC?** Data for the research was collected via the quantitative method, the sample size was 234. The analysis ways are conducted as follows: the descriptive records, reliability and normality testing, and speculation checking out will be conducted through the use of correlations and the model will be proven with the use of linear a couple of regressions. As the results identified a significant relationship between Independent Variables and Dependent Variables.

Key Words : Employees' Personal Characteristics (EPC), Employees' Professional Characteristics (EPRC), Teleworking, Virtual Project (VP), Work Environment Characteristics (WEC)

Introduction

The IT industry is moving to virtual platforms to achieve business goals due to rapid changes and challenges. Based on that, the teleworking concept arose (Agarwal, et al., 2020). The management of the VP handling concept is more effective and successful to make quick responses to market competition (Nozari, et al., 2016). Due to the past pandemic situation and government restrictions all IT companies were follow the teleworking concept (Godar & Ferris, 2020). For that reason, more than 40% of workers used telework in 2020 (Catana, et al., 2021) and (Iqbal & Nauman, 2020). It is difficult to manage, due to some technical issues, lack of communication, lack of decision-making and strategy-making, issues of trustworthiness, and day-to-day life with family (Vasic, 2021).

ABC (PVT) Ltd Sri Lanka

ABC Sri Lanka, through totally-fledged advertising, sales, consulting, and guide entity equipped to cater to the quit-to-give-up essential of any client. "The Sri Lankan sales and marketing activities are strongly integrated with ABC's major R&D middle outdoor, located in Colombo Sri Lanka. Presently employs over 700 personnel and is also a roof to ABC's global support and training center

Pandemic and Global Tendency of Teleworkers

The global market had to face the covid-19 pandemic situation strictly (World Health Organization, 2022). Due to the world's covid-19 health restrictions, ABC Sri Lanka also accepted the teleworking concept. According to, (Morgan, 2014) the growth of teleworking is based on the proliferation of flexible working practices, not the job roles. Also, Morgan

shows nine occupational categories which influence teleworkers (managerial, professional, administrative, etc.).

Globally (Aboelmaged & El Subbaugh, 2012) show, crucial roles of individuals and organizational factors are influencing 80% of the perceived productivity of teleworkers; job security, satisfaction, flexible works, and management support are common factors; which can identify among past research.

Research Objectives

1. To Identify the enabling and inhibiting factors for software project success under teleworking.
2. To measure the level of impact each of these factors has on software project success at ABC PVT Ltd.
3. To make evidence-based actionable recommendations to enhance the chances of software project success at ABC PVT ltd in the new normal.

Significance of the Study

This study is important to both employees and employers who are working on the project in Teleworking mode. Especially when focusing on the team members, EPC (family, personal matters, work transfer, lack of communication, etc), EPRC (lack of technical knowledge, lack of self-motivation, lack of job satisfaction, etc), WEC (lack of job opportunities, lack of leadership/management/supervising, etc). It is utilizing people, technology, network, information, hardware, and software to achieve analysis targets (Conill, 2013). Employees and employers can get different types of benefits such as eliminating the need to relocate, reducing stress, increase employee productivity, and satisfaction (Nakrosiene, et al., 2019). Also, it will be in good health for increasing labor satisfaction and retention and mainly improving the quality of work.

Methodology

Conceptual Framework and Hypotheses

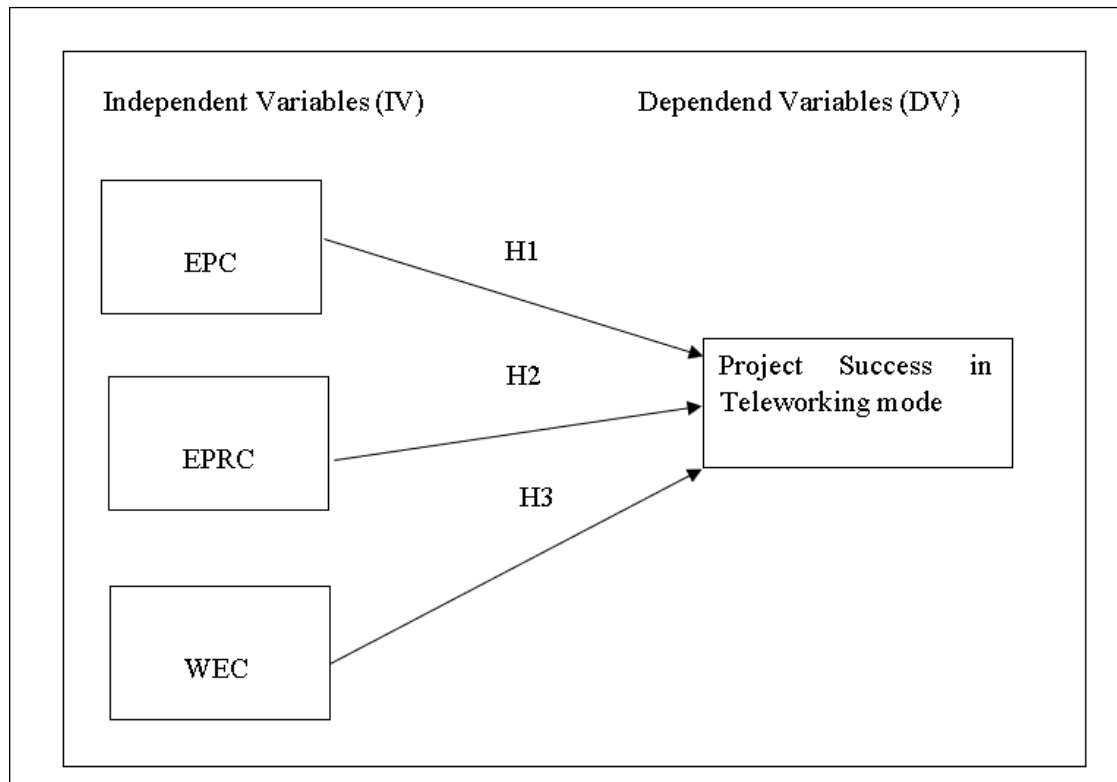


Figure 1: Conceptual Framework

The relationship between the IV could be impacted by the DV Project Success in Teleworking Mode. Hypotheses resulting based on this conceptual framework will be statistically verified to understand whether all will be negative or positive.

Null Hypothesis (Ha0), Alternative Hypothesis (HaA)

<p>Hypothesis 01</p> <p>H1;0: Employees' Personal Characteristics have no relationship with Project Success in Teleworking Mode</p> <p>H1; A: Employees' Personal Characteristics have a relationship with Project Success in Teleworking Mode</p>
<p>Hypothesis 02</p> <p>H2;0: Employee's Professional Characteristics have no relationship with Project Success in Teleworking Mode</p> <p>H2; A: Employees' Professional Characteristics have a relationship with Project Success in Teleworking Mode</p>
<p>Hypothesis 03</p> <p>H3;0: Work Environmental Characteristics have no relationship with Project Success in Teleworking Mode</p> <p>H3; A: Work Environmental Characteristics have a relationship with Project Success in Teleworking Mode</p>

Figure 2: Hypothesis

Population and Sample Size

ABC had worked on 40 projects and 15 employees are assigned to each project in teleworking mode, but the team structure was not changed. Also, this research focuses only on 2021 projects.

Table 1: Population and Sample Size

Number of Projects (2021)	Number of Team Members for Each Team	Population
40	15	40*15= 600

The sample size has been determined by using Morgan's sample pattern (Creative Research Systems, 2012) for the populace of 600 at a 95% confidence level and a 5% confidence interval comes out to be 234.

Data Collection Methods and Techniques Used for the Research Analysis

The statistics collection became executed using a quantitative survey questionnaire managed through a questionnaire with google forms. The records analysis became carried out using the IBM SPSS tool version 20. When focusing on research analysis. All

hypotheses trying out become done using Pearson Correlation, and to validate the blended model a couple of Linear regressions become used.

Results

Hypothesis Testing

Hypothesis 01

Pearson Correlation

Table 2: Pearson Correlation

Correlations			
		Employee Personal Characteristics	Virtual Project Success
Employee Personal Characteristics	Pearson Correlation	1	.437**
	Sig. (2-tailed)		.000
	N	234	234
	Pearson Correlation	.437**	1
Virtual Project Success	Sig. (2-tailed)	.000	
	N	234	234

** . Correlation is significant at the 0.01 level (2-tailed).

EPC has a significantly moderate positive relationship with project Success, $r = 0.437$, $p = 0.00$, two-tailed. The $H1;0$ can be carefully rejected, and the $H1;A$ can be accepted. Furthermore, statistically proving (0.437) there is a significant positive relationship between EPCs and project success in teleworking mode. The scatter plot diagram represents the linear relationship between EPC and project success (0.191) with the best fit line represented in the scatter diagram.

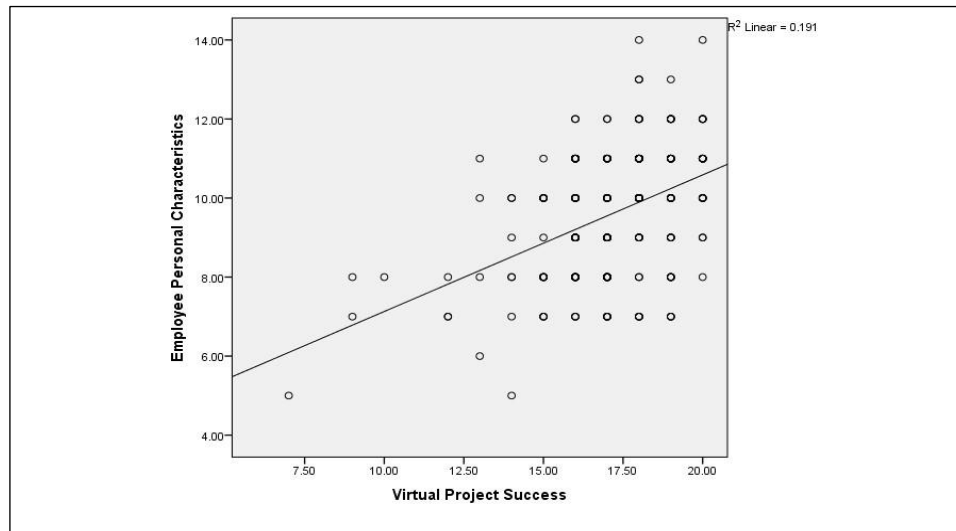


Figure 3: The Scatter Plot Diagram

Regression Analysis; EPC and Project Success

Table 3: Regression Analysis; EPC and Project Success

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.437 ^a	.191	.187	1.83274

a. Predictors: (Constant), Employee Personal Characteristics

b. Dependent Variable: Virtual Project Success

EPC affects 19.1% of the variance of project success, $R^2 = 0.191$. Thus, 80.9% of the variation of the DV can be explained by other factors.

Table 4: ANOVA Table

ANOVA^a

Model	Sum of Squares	df	Mean Square	F	Sig.
1 Regression	183.636	1	183.636	54.671	.000 ^b
Residual	779.270	232	3.359		
Total	962.906	233			

a. Dependent Variable: Virtual Project Success

b. Predictors: (Constant), Employee Personal Characteristics

As the significant value of the ANOVA table of the regression analysis is 0.00 and is significant, it indicates that the model is significant.

Table 5: Coefficient Values

Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	11.787	.724		16.274	.000
1 Employee Personal Characteristics	.552	.075	.437	7.394	.000

a. Dependent Variable: Virtual Project Success

Concerning the standardized coefficient values indicate, a one-unit increase of EPC increases projects success by 0.437 units which is significant at 0.00. As per the Pearson correlation and the regression analysis, it is evident that there is a significant connection between EPCs and project success.

Hypothesis 2

Pearson Correlation

Table 6: Pearson Correlation

Correlations

		Virtual Project Success	Employee Professional Characteristics
Virtual Project Success	Pearson Correlation	1	.622**
	Sig. (2-tailed)		.000
	N	234	234
Employee Professional Characteristics	Pearson Correlation	.622**	1
	Sig. (2-tailed)	.000	
	N	234	234

** . Correlation is significant at the 0.01 level (2-tailed).

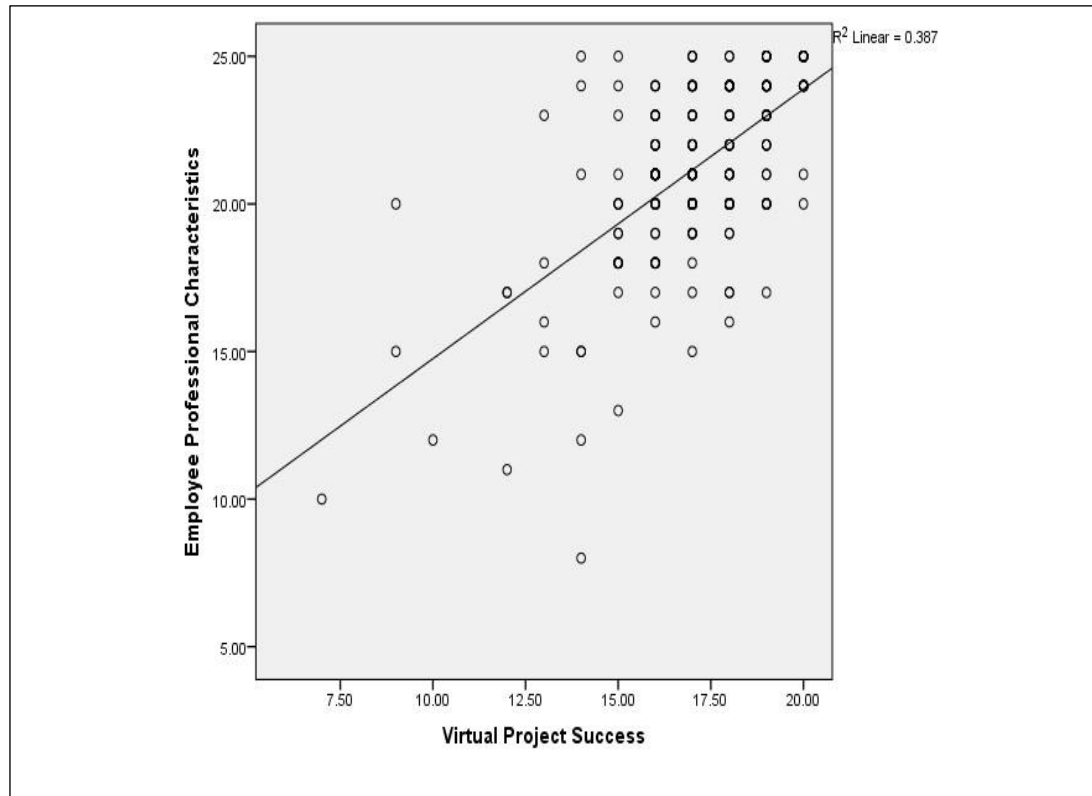


Figure 4: The Scatter Plot Diagram

Strong positive significant correlation between EPRC and project success, $r = 0.622$, $p = 0.01$, 2-tailed. The $H_2;0$ can be carefully rejected, and the $H_2;A$ can be accepted. Finally, generate the R-square value is 0.387 which indicates up to 38% of validity in the project success in teleworking mode.

Regression Analysis; EPRCs and Project Success

Table 7: Regression Analysis; EPRCs and Project Success

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.622 ^a	.387	.384	1.59535

a. Predictors: (Constant), Employee Professional Characteristics

b. Dependent Variable: Virtual Project Success

EPRC has a 38.7% impact on the variation of Project Success, $R^2 = 0.387$

Table 8: ANOVA Table

ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	372.434	1	372.434	146.332	.000 ^b
	Residual	590.472	232	2.545		
	Total	962.906	233			

a. Dependent Variable: Virtual Project Success

b. Predictors: (Constant), Employee Professional Characteristics

As the significant value of the ANOVA table is 0.00, it shows that the regression model is significant.

Table 9: Coefficient Values

Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	8.088	.750		10.784	.000
1 Employee Professional Characteristics	.423	.035	.622	12.097	.000

The standardized beta value shows that a one-unit increase in EPRC increases projects success by 0.622 units. It is significant at 0.00.

Hypothesis 3

Pearson Correlation

Table 10: Pearson Correlation

Correlations		Work Environmental Characteristics	Virtual Project Success
Work Environmental Characteristics	Pearson Correlation	1	.290**
	Sig. (2-tailed)		.000
	N	234	234
Virtual Project Success	Pearson Correlation	.290**	1
	Sig. (2-tailed)	.000	
	N	234	234

** . Correlation is significant at the 0.01 level (2-tailed).

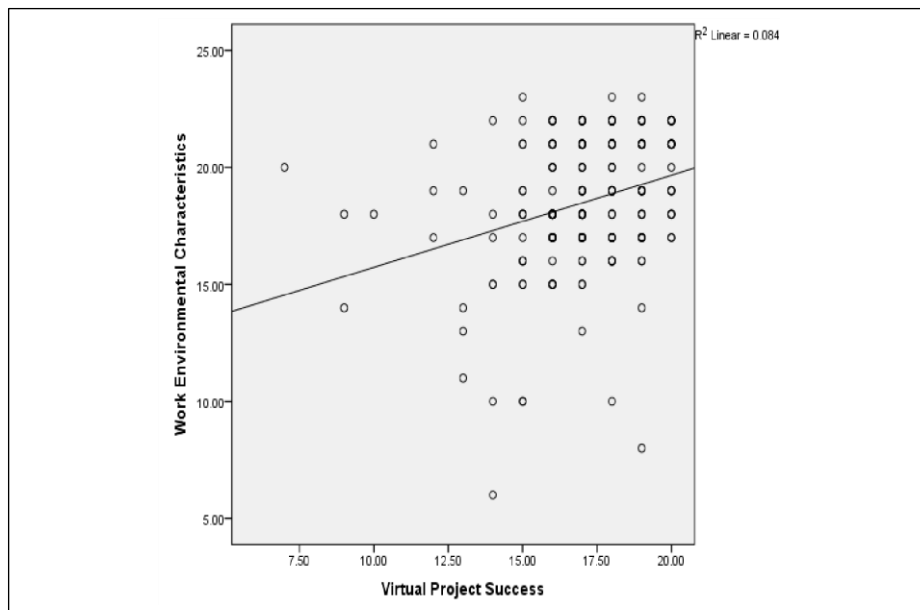


Figure 5: The Scatter plot Diagram

There is a weak significant relationship between WEC and project success, $r = 0.290$, $p = 0.00$.

The $H_{3;0}$ can be carefully rejected, and the $H_{3;A}$ can be accepted. Finally, generate the R-square value is 0.084 which indicates up to 8.4% of validity in the project success in teleworker mode.

Discussion

EPC, EPRC, WEC, and Project Success in Teleworking Mode.

The Pearson correlation indicated that there is a moderate positive relationship between EPCs and Project Success. The regression analysis showed that EPCs affect 19.1% of Project Success. A one-unit increase in EPC will increase Project Success by 0.622 units. Hence, the H1 was accepted: **There is a significant positive relationship between EPCs and Project Success.** Ameer *et al.*, (2021) showed that the personal factors of employees will affect project success.

The Pearson correlation showed that there is a moderately strong positive relationship between EPRCs and Project Success. The regression analysis results indicated that EPRCS has a 38.7% positive impact on Project Success. To elaborate, a one-point increase in EPRC contributes to increases in Project Success by 0.622 units. The highest contribution towards the Project's success is made by EPRCs as per the results of the current study. Hence, the H2 of the study was accepted. **There is a significant relationship between EPRCs and Project success.** A significant study by Vrchota *et al.*, (2021), showed the importance of EPCs that affect project success via Leadership style, flexible environment, etc.

WECs had a positive weak relationship with Project Success. The regression analysis showed that WECs had an 8.4% contribution towards the increase of Project Success and a one-unit increase of WECs increased Project Success by 0.29 units. WEC has the least impact on project success in comparison to EPCs and EPRCs. Hence, H3 of the study was accepted: **There is a significant relationship between WEC and Project Success.** Rydell *et al.*, (2019) distinguished that the work environment is a critical component of success within an organization. Wang *et al.*, (2020) study noted that organizational support is essential for creating a healthy and less toxic workplace.

Conclusion

The ABC can make a proper and effective teleworker arrangement after analyzing the result of this study. It will be beneficial for both individual teleworkers and the organization in the long run to handle software projects. Because during the pandemic situations mainly focused on the safety of each worker.

Recommendations

EPC affects 19.1% of the variance of project success, ($R^2 = 0.191$). It has a lower level impact on project success than other IVs. However, with unpredicted human factors, the management of ABC needs to balance EPCs effectively. Therefore, the study suggests making boundaries between work (ex: overworking) and personal life to maintain less impact from EPCs based on an effective psychological manner.

EPRC has a 38.7% impact on the variation of Project Success in teleworking mode, ($R^2 = 0.387$). That means EPRC can be highly impacted by the project success in ABC. To maintain/reduce the impact level of percentages of EPRC, suggest making a variety of changes within job tasks, duties, and responsibilities of workers. Also, an automation productivity platform will positively impact teleworkers.

The R-square value of WEC is 0.084 which indicates up to 8.4% of validity in the project success in teleworking mode. Have transparent and open communication within the work environment to show the teleworkers that they are valued. Discuss the organization's mission, vision and values occasionally to assure that the teleworkers are aware of the overall objectives of the company. Open and transparent discussions will also increase innovation (Virtual reality concept) within the company will suggest to ABC.

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**EFFECTIVE SOLUTIONS TO OVERCOME WILDLIFE CHALLENGES IN
AIRPORT CONSTRUCTION CASE STUDY ON MATTALA RAJAPAKSHA
INTERNATIONAL AIRPORT SRI LANKA**

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Abstract

The primary aim of this study is to develop a conceptual framework to overcome wildlife challenges when constructing international airports in Sri Lanka. Identify and analyse environmental challenges and impacts (wildlife) related to airport projects, examine wild life impact on airport projects, identify provided solutions to overcome wildlife challenges and identify environmental proposed reports. For this study, secondary data were gathered from books, individual sources, journals, newspapers, websites, and government documents. Many international airlines have opted out of visiting MRIA in this situation, which has impacted the airport's operations. Bird strikes and wild life treats are few problems faced in the airport project to be a success. Peacocks are said to frequently wander into the airport from nearby shrub jungles, including the runway. Authorities started disrupting habitats when a plane struck two peacocks at Sri Lanka's new airport. Bird strike is a major problem for the operation of Mattala International Airport. The MRIA airport project suffered greatly from a lack of scientific input, resulting in significant economic and ecological losses.

Keywords : Bird strike, Civil Aviation Authority, Environmental Impact Assessment, Mattala Rajapaksha International Airport, Wild animal threats

Introduction

An airport has an impact on Jobs and income and the community's economy enormously. Megaprojects are often seen as significant forces behind social advancement. Despite being the global best practices, multiple obstacles can turn a mega project's anticipated success into a failure scenario. Sri Lanka is building its second international airport, known as Mattala Rajapakse International Airport. The construction work on a 2,000-hectare plot of land began on November 17, 2009, with a total expenditure of US\$ 243.7 million. On March 18, 2013, the International Airport officially opened for business.

Sri Lanka has only the Bandaranaike International Airport (BIA) for emergency situations and no backup airport due diversion from BIA. Just 14 incidents of an aircraft being diverted due to inclement weather were recorded in historical statistics on aircraft diversions at BIA between 1996 and 2006. Mattala International Airport's operations were restricted to one aircraft after political changes in 2015. The MRIA project underwent an EIA during the 2008–2009-time frame, and the locations chosen were near environmentally sensitive wetlands. Since the selected project site was a complete scrub forest, the negative impact on livelihoods in this area was relatively small.

Many international airlines have opted out of visiting MRIA in this situation, which has impacted the airport's operations. Below describes few problems faced in the airport project. The area around MRIA is a popular stopover for migratory birds. Peacocks are said to

frequently wander into the airport from nearby shrub jungles. Authorities started disrupting habitats when a plane struck two peacocks at Sri Lanka's new airport in January.

The area around MRJA is a popular stopover for migratory birds. Due to the abundance of water supplies and nesting grounds surrounding the airport, no reduction of bird flow as expected during airport operations. This has been viewed by several aircraft carriers as posing a threat to both the planes and the travellers. Since the opening of Mattala International Airport, there have been numerous reports of bird and airplane collisions. Peacocks are said to frequently wander into the airport from nearby shrub jungles, including the runway. Authorities started disrupting habitats when a plane struck two peacocks at Sri Lanka's new airport in January.

A wild elephant attacked a week before the airport's opening (the victim died subsequently). The access road in particular had split the habitat of wild animals, causing them to wander along the road. It has been reported that there are more than 300 elephants in the airport development area.

The MRJA airport project suffered greatly from a lack of scientific input during the design and execution phases, which resulted in significant economic and ecological losses. It is now referred to as the "white elephant" project of the previous government. Reviewing the ranking values given for each criterion in the EIA report is crucial because there were clear issues with wildlife and bird strikes after implementation. Mattala was one of the country's most ecologically valuable areas, with numerous endangered and unusual plant and animal species that have been damaged by the airport.

Study aims to develop a conceptual framework to overcome wildlife challenges when constructing international airports in Sri Lanka. The main aim of the study is to identify and analyse environmental challenges and impacts (wildlife) related to airport projects, as well as provide provided solutions to overcome them.

Methodology

Case study is based on Mattala Rajapaksha International Airport on how to overcome environmental challenges in airport project. Secondary data research involves acquiring information that has previously been gathered from a variety of sources. This applies to both internal sources, such as internal research, and external sources, which are more usually used. Figure I shows the conceptual framework of the MRJA project.

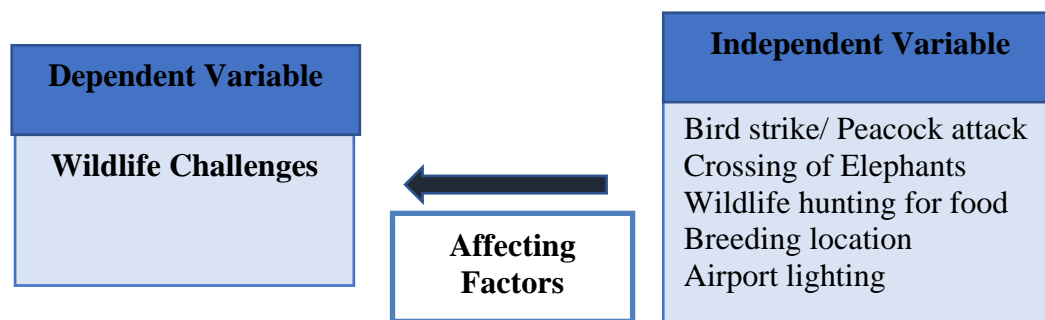


Figure I: Conceptual Framework

Data Analysis and Discussion

The negative effects of human activity on the planet's climate are one of the biggest environmental issues the aviation industry faced. Aircraft emissions have the potential to negatively affect the ozone layer, climate, and air quality. Ground support equipment is another source of aviation-related emissions at the airport and at ground level. As a result, for the above implement green across the company as done by the Airport and Aviation Services (Sri Lanka) Limited (AASL).

With the right strategies, active wildlife management and bird control can be successfully applied. Gulls, waterfowl (ducks and geese), doves, blackbirds, hawks, eagles, and owls are typical "problem" groups. MRIA need a year-round, and occasionally 24-hour, control procedures. A well-trained and motivated field team as well as a sufficient quantity of suitable and well-maintained control products reflect on the wildlife impact in airport projects.

Need to conduct a second EIA for the project for post impacts upon commissioning of the airport MRIA. Need to outline important bird species that the airport has an impact, as well as those that would have an impact on airport traffic. The river and the landfill are the main areas of concern where the birds would attract. The impact on the enhancement of scientific contributions should be recognized during the pre-planning stage by the EIA process. Table I points out few further scientific inputs for different stages of the project that need to be considered in airport projects.

Table I: Important scientific inputs for planning and execution phases of MRIA

Project stage	Further scientific input
Planning Stage	<ul style="list-style-type: none">• The EIA require extra research of the behavior of wildlife conducted by experts (observations alone cannot be considered scientific input).• The EIA analysis should utilize quantitative methods to support the selection of the site (the analysis used the ineffective Qualitative Ranking Method).• Water resources and noise impacts are subjected to scientific analysis.• A cost-benefit analysis should be performed by estimating habitat fragmentation, biodiversity loss, and financial gains using valuation methodologies.• Recommendations from specialized organizations like the Department of Wildlife Conservation (DWC) and the Forestry Department (FD)
Operational Stage	<ul style="list-style-type: none">• Using manual labor to get rid of animals like birds and elephants instead of altering behavior.• Reduce new problems like wildlife attraction into MRIA water sources, etc.

Environmental Impact Assessment (EIA) offers extra information that uses to make better decisions to the planning and decision-making process. EIA report is essential in planning

International Airport. When constructing another airport or considering of making MRIA a successful project, the implementation agencies should put their primary attention on managing any unwanted effects.

Conclusion and Recommendations

The government should sit down with the appropriate stakeholders and assess the potential at hand and the challenges ahead. The EIA's review should include an autonomous risk assessment and a strong evaluation and monitoring plan. The EIA report should be published to access to the public and all reports and research done on future projects should be open to public.

The ecological impact assessment portion of any EIA report should be given top importance in order to analyse the real condition of the impact area. The "No Project" alternative should be taken into account when evaluating eco system services and numerous options and range of ecological inputs. Impact assessment need to be done in each and every project stage on important eco system components, in this case the movement of birds and elephants.

As an opinion it is advised to conduct more research on this subject. I believe there is a lot more research and experimentation that can teach us about managing wildlife challenges. Sharing knowledge about habitat management among airports might also be beneficial. The danger can never be completely eradicated; therefore, airport staff must be thoroughly trained and equipped to manage the continuous cycle of risk assessment and elimination

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EVALUATING COMMUNICATION CHALLENGES FACED WITHIN AGILE REMOTE TEAMS ON SUCCESS OF IT PROJECTS IN SRI LANKA

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Abstract

Many organizations now incorporate Agile Methodology with software development because of the multiple benefits it provides, such as faster time to market, cheaper and skilled labour, 24-hour development, and better project control. Effective team communication is critical to the agile approach, as proper and continuous feedback is required to boost team productivity and software quality. Because processes that follow Agile methodology approaches prioritize individuals and interaction, it was determined to investigate communication challenges in teams that use such processes. This study presents a conceptual framework for communication obstacles such as language barriers, virtual communication tools, communication standards, and concerns of leadership and trust. For this study, a quantitative method was chosen, and an initial stage of the study included a systematic literature review. The research reports on survey conducted among 100 IT professionals who have worked in agile virtual teams. The survey data analysis revealed that the majority of respondents assessed the framework components as effective, making the latter viable for implementation by remote agile software projects.

Keywords: Agile software development, Communication challenges, Communication framework Distributed teams, Virtual software development teams

Introduction

Background of the study

Analysis of communication problems in teams using Agile methodology procedures was chosen because these processes place the highest focus on people and engagement (Yermolaieva,2020). In general, traditional projects have a communication plan, whereas agile scrum projects communicate in both formal and informal ways based on the project structure and Agile scrum virtual project communication occurs during a number of scrum ceremonies, such as the sprint review meeting (Walimbe,2016).

Objectives of the study

Objective one: To suggest a framework about communications challenges faced within agile virtual teams in the IT sector.

Objective two: To scrutinize each variable in the communication challenges framework model and its impact on the IT project success.

Objective three: To provide recommendations using the developed framework to achieve IT project success by effectively handling communication challenges.

Significance of the study

With the recent 2020 Covid pandemic there shows a significant rise of remote teams following agile framework in the IT sector. There is a sharp rise in the remote agile teams in throughout the recent years in the IT sector which became pervasive among the IT workforce with the recent covid pandemic.

80% of global corporate remote work practices had shifted to virtual and mixed types of virtual team collaboration during the early phases of the coronavirus outbreak. Because of COVID-19, according to 64% of firms, the change to virtual teamwork will probably be permanent (Meluso et al., 2020)

Methodology

Conceptual framework of the research

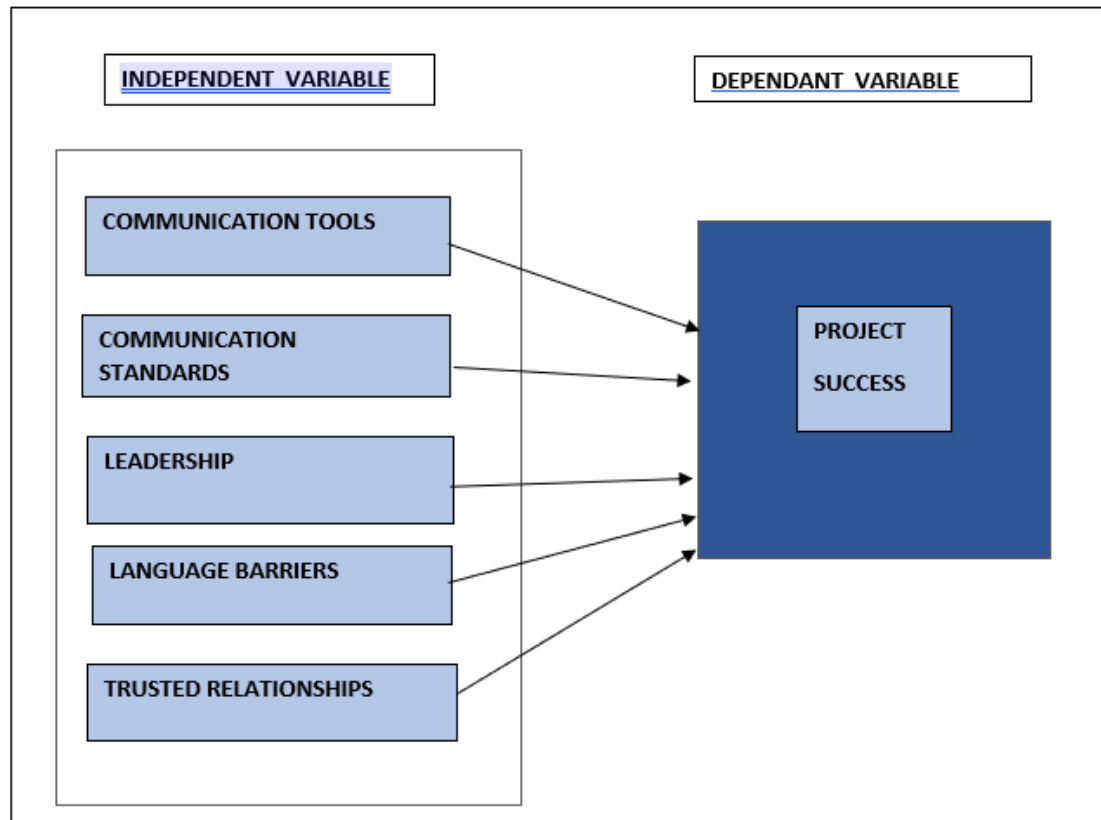


Figure 1: Conceptual Framework

Development of hypotheses

Communication Challenges (IV)	Project performance (DV)
Communication Tools	Project Success
Communication Standards	
Leadership	
Language Barriers	
Trusted relationships	

Figure 2: Development of Hypothesis

Hypothesis	Communication Challenges (IV)	Project performance (DV)
H1a	Communication Tools	Project Success
H2a	Communication Standards	
H3a	Leadership	
H4a	Language Barriers	
H5a	Trusted Relationships	

Figure 3: Hypothesis Formation

H1a: Alternate

hypothesis H1o: Null hypothesis

- H1a – Communication Tools have an impact the success of IT projects.
H1o – Communication Tools has no impact on the success of IT projects.
H2a –Communication Standards have an impact the success of IT projects.
H2o – Communication Standards have no impact on the success of IT projects.
H3a – Leadership has an impact the success of IT projects.
H3o – Leadership has no impact on the success of IT projects.
H4a – Language Barriers have an impact the success of IT projects.
H4o – Language Barriers have no impact on the success of IT projects.
H5a – Trusted Relationships positively impact the success of IT projects.
H5o – Trusted Relationships have no impact on the success of IT projects.

Operationalization

Concept	Variable	Measuring Dimesnsion	Measurement Method	Relevant Question
Independent Variable	Communication Challenges	Communication Standards	Likert Scale 1-5	Q5 -Q8
		Communication Tools		Q9 -Q12
		Leadership		Q13-Q816
		Language Barrier		Q17-Q20
		Trust Relationships		Q21 -Q24
Dependent Variable	Project Success	Time, Scope, Cost	Likert Scale 1-5	Q25- Q26

Figure 4: Operationalization Table

Sampling design

Probability sampling is used because quantitative research is carried out to gather the data. Probability sampling is used for the study due to plethora of reasons like the ability to draw conclusions about the population utilizing an effective approach for picking samples from a vast population base, cost effectiveness, simplicity, and direct nature in its execution, the lack of systematic error and bias in the sampling.

Since everyone has an equal chance of being selected for the population sample when using this methodology, simple random sampling technique is employed as the probability sampling method. The data is chosen randomly using a table of random numbers or a list of randomly generated numbers produced by a computer. Simple random sampling is used for this research because it provides various benefits like it only requires a very limited amount of prior knowledge of the population under study, there are no classification errors, Can be used for data analysis, including inferential statistical analysis, it is completely free of prejudice and bias.

POPULATION		SAMPLE
ICT Professionals in Sri Lanka		ICT professionals who have worked or working in remote teams which practice Agile methodologies.

Figure 5: Population Vs Sample

Sample selection procedure

The questionnaires will utilize probability sampling and a Likert scale that is dispersed to 130 IT professionals who has experience in working in agile remote teams in Sri Lanka, in which 100 individuals who have sent responses.

1.96 is the z value corresponding to 95% confidence interval. The population size is taken as more than 100 000 in IT sector of Sri Lanka.

Margin Error calculation = 9.8

By using a random sampling method and Cochran's formula, 100 individuals are considered as the sample size at 95% confidence interval.

Data collection methods

The research will consist of quantitative data analysis which will be conducted through distributing questionnaires to ICT professionals working in the IT sector in Sri Lanka. Probability sampling is selected because techniques used in the probability sampling produce better results which are representative of the whole population. A quantitative study is conducted because the research is aimed at proving a hypothesis.

Utilizing questionnaires, where all data may be acquired from human respondents, is one technique to gather primary research data or new research data. The questionnaires are created through google forms and distributed online. The secondary research, or already published data, is gathered from reliable sources like books, journal articles, and other academic publications that have already been authored by accomplished authors.

The most significant communication problems experienced by agile remote groups in the software industry will be identified using the most recent knowledge that was discovered by conducting systematic literature review.

In order to refine the questions based on the participant responses to the questionnaires, a pilot survey is employed. The questions will then be changed based on how well the answers were communicated.

Results

Demographics of research participants

Majority of the participants were Software Engineers which accounts for 70% out of total respondents.

1. What is your designation (Current role) in the project?

100 responses

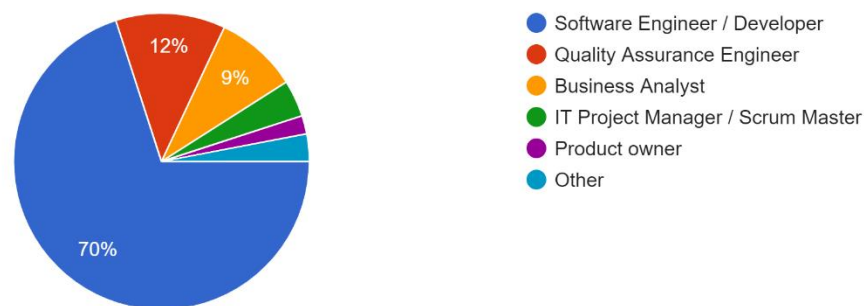


Figure 6: Question 1

Majority of the professionals who responded worked for the private sector organizations which consist of 90%.

2. Which sector do you work for?

100 responses

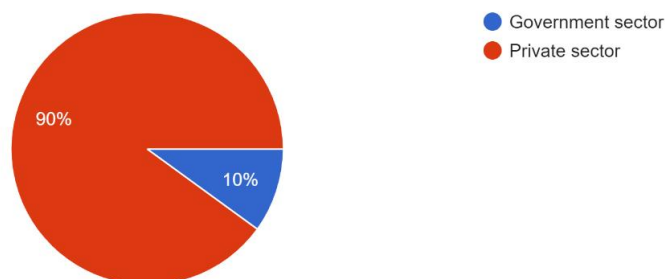


Figure 7: Question 2

The highest number of the research participants have 4-7 years of working in the IT industry which consists of 40% out of the overall respondents.

3. How many years of experience do you have working in software industry?

100 responses

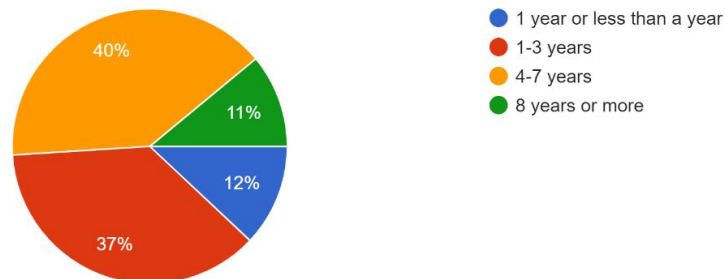


Figure 8: Question 3

Almost all participants have experience in working with Scrum agile methodology accounting for 97%.

4. Which agile methodologies professionals have experience with?

100 responses

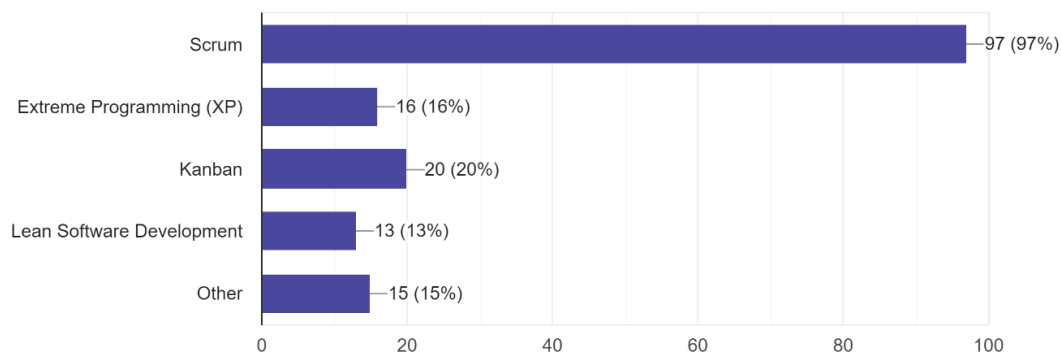


Figure 9: Question 4

Multiple Regression Analysis

Regression

[DataSet0]

Variables Entered/Removed^a

Model	Variables Entered	Variables Removed	Method
1	LEADERERSHIP, COM_TOOL, LANG_BARRIER, TRUST_RELATION, COM_STANDARD ^b	.	Enter

a. Dependent Variable: PROJ_SUCCESS

b. All requested variables entered.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.810 ^a	.655	.637	.53106

a. Predictors: (Constant), LEADERERSHIP, COM_TOOL, LANG_BARRIER, TRUST_RELATION, COM_STANDARD

Figure 10: Model Summary

All five variables together are strongly positive because the R value is 0.810. According to the adjusted R square value, all variables together mentioned in the conceptual framework like communication tools, communication standards, leadership, language barrier and trusted relationships contributed towards the dependant variable project success is by 63%. The remaining 37% is due to other unknown factors.

ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	50.418	5	10.084	35.754	.000 ^b
	Residual	26.510	94	.282		
	Total	76.928	99			

a. Dependent Variable: PROJ_SUCESS

b. Predictors: (Constant), LEADERERSHIP, COM_TOOL, LANG_BARRIER, TRUST_RELATION, COM_STANDARD

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-.146	.339		-.432	.666
	COM_TOOL	.255	.092	.213	2.770	.007
	LANG_BARRIER	.265	.096	.257	2.777	.007
	TRUST_RELATION	.425	.098	.426	4.344	.000
	COM_STANDARD	-.079	.120	-.065	-.657	.513
	LEADERERSHIP	.124	.131	.110	.944	.347

a. Dependent Variable: PROJ_SUCESS

Figure 11: ANOVA Table

According to the ANOVA table sig value is still .000. to all the five variables to the dependant variable projects success. Therefore, the conceptual framework for the research is considered acceptable.

The predictor variables are displayed in the first column of the coefficient table. The first variable (constant), usually referred to in textbooks as the constant or the Y intercept, measures the height of the regression line where it crosses the Y axis. In other words, when all other variables are 0, this is the projected value of project success. The B column contains the values for the regression equation that was used to predict the dependent variable from the independent variable.

$PROJ_SUCESS_{Predicted} = -1.46 + .255*COM_TOOL + .265*LANG_BARRIER + .425*TRUST_RELATION + -.079*COM_STANDARD + .124 *LEADERSHIP$

The correlation between the independent and dependent variables is revealed by these estimations. These projections show how project success would increase with a 1 unit increase in the predictor.

The coefficients are displayed in the beta column and were produced by standardizing each and every variable in the regression, including both the dependent and independent variables. The variables must all be put on the same scale by standardizing them prior to conducting the regression, making it simple to compare the magnitude of the coefficients to determine which variable has the greatest impact. In the above table Trust relation variable has a higher impact than others with the value .426. The bigger t-values are typically correlated with the larger betas.

Reliability test

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.910	.911	6

Item Statistics			
	Mean	Std. Deviation	N
COM_TOOL	3.9875	.73716	100
COM_STANDARD	3.9625	.72070	100
LEADERERSHIP	3.9175	.78339	100
LANG_BARRIER	3.5725	.85376	100
TRUST_RELATION	3.8750	.88442	100
PROJ_SUCCESS	3.6350	.88150	100

Inter-Item Correlation Matrix						
	COM_TOOL	COM_STAND ARD	LEADERERS HIP	LANG_BARRI ER	TRUST_RELA TION	PROJ_SUCC ESS
COM_TOOL	1.000	.545	.577	.409	.534	.574
COM_STANDARD	.545	1.000	.767	.583	.659	.567
LEADERERSHIP	.577	.767	1.000	.711	.724	.675
LANG_BARRIER	.409	.583	.711	1.000	.689	.678
TRUST_RELATION	.534	.659	.724	.689	1.000	.754
PROJ_SUCCESS	.574	.567	.675	.678	.754	1.000

Summary Item Statistics							
	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Item Means	3.825	3.573	3.988	.415	1.116	.031	6
Inter-Item Correlations	.630	.409	.767	.358	1.877	.009	6

Item-Total Statistics					
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
COM_TOOL	18.9625	12.687	.610	.427	.913
COM_STANDARD	18.9875	12.190	.740	.622	.897
LEADERERSHIP	19.0325	11.400	.835	.732	.883
LANG_BARRIER	19.3775	11.459	.734	.605	.897
TRUST_RELATION	19.0750	10.895	.814	.683	.885
PROJ_SUCCESS	19.3150	11.061	.783	.655	.890

Scale Statistics			
Mean	Variance	Std. Deviation	N of Items
22.9500	16.432	4.05362	6

Figure 12: Reliability Test

The Cronbach's alpha is .910 and since its above 0.9, the internal consistency is considered to be excellent.

Discussion

It has been founded in the research that trusted relationship factor in has extremely strong positive relation with project success among all the other variables in the conceptual framework. Therefore, this study may be used by scholars and practitioners to comprehend various trust-related problems and investigate various techniques for fostering trust among agile team members in dispersed software development projects.

The research's findings are useful for managers, product owners, SCRUM masters, and team leaders who wish to delve into the underlying reasons why Agile team members don't interact well. By recognizing what category, the recommendations fall under, it will be easier to understand how to handle communication problems. This study aims to provide a framework employing a number of variables that managers of virtual teams might utilize to create effective relationships among the team members. Since virtual teams allow a group of gifted, extremely competent, and experienced people spread out across different locations to collaborate on the completion of a specific task without being relocated, both members and organizations can use these factors to analyze their teams and their members effectively.

Conclusions and Recommendations

These preliminary results are encouraging and show that the suggested methodological framework may be applied to successfully manage by IT communication issues faced projects which utilize agile virtual teams.

It is hoped that this dissertation will be useful to those who will read it in the future and want to learn more about the communication difficulties agile remote teams in Sri Lanka's IT industry confront. With the help of this research, many businesses may create more effective strategies, pinpoint and address the main communication issues affecting Sri Lanka's software industry.

It demonstrates that, despite its challenges, virtual communication within agile teams can be appealing to IT specialists, something that appears to be essential in the present IT labor market, where companies are vying for the best of them.

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BARRIERS FOR IMPLEMENTING EFFECTIVE PROJECT MANAGEMENT PRACTICES IN SRI LANKAN CONSTRUCTION PROJECT

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Abstract

This paper's main goal is to identify and discuss the difficulties associated with project management in the construction industry and involves in identifying the barriers affecting on Project Management practices and how those barriers influence on successful delivery of construction projects. Through the literature review it has been identified the barriers of Project Management and the solutions for them in order to mitigate them. Based on the literature review a questionnaire survey was conducted and obtained data from 37 respondents those who are currently having the experience in the construction industry. A theoretical framework has been developed in this study to minimize the hindrance factors of Project Management in construction projects. The results of this study show that the objectives of Project Management practices should be achieved to deliver a successful completion of construction projects satisfying the requirements of time, cost, and quality. The outcome from this study will result in minimizing the effect of hindrances of Project Management towards successful project completion.

Keywords: Barriers, Construction, Effective, Project Management, Successful

Introduction

Project Management is an important aspect in a successful project, and it can be called as the science and art of coordination. Most of the construction projects face the challenge of completing the project as scheduled within the estimated budget and the expected quality. This will result in claiming for additional cost and time which might even lead to disputes. Such situations occur due to poor Project Management in most of the construction projects (Patil, 2016). Therefore, the availability of just and fair Project Management practices is of high importance in a construction project.

Project management practices and principles have a prominent place in any successful project in the construction sector, even though there are some things to be concerned about when it comes to the success of construction projects. The objectives of this study are to identify the barriers for implementing Project Management practices in construction industry and understand the importance of implementing Project Management practices in Sri Lankan construction industry to deliver successful construction projects.

Moreover, this research aims in developing a framework to minimize the barriers for implementing Project Management practices in construction projects. Identifying the barriers for implementing Project Management practices in construction industry and understanding the importance of implementing Project Management practices in Sri Lankan construction industry to deliver successful construction projects are the objectives in this research to accomplish the aim. Overall evaluation of barriers in Project Management has been carried out in order to find out the root cause of barriers towards successful project completion. In addition, the strategies which need to be implemented as mitigating factors are discussed as a solution to the hindrance factors.

In Sri Lanka, the public sector enters into a wide range of contracts with vastly different values, lengths of time, and levels of complexity. Because each contract is different in size, structure, complexity, and risk profile, so are the type and scope of contract management procedures. The general concepts and procedures that apply to such contracts must therefore be understood by entities and other parties involved in managing contracts. They will then be able to select contract administration and management techniques that are suitable for their specific circumstance. Lack of this information will result in significant time, quality, and financial waste on the part of the government.

Methodology

The data collection was mainly carried out through a comprehensive literature review and quantitative analysis. Major barriers for the implementation of project management practices have been basically identified through literature review and then those barriers were further evaluated through a questionnaire survey. The questionnaire survey was distributed among 40 professionals engaging in the construction industry. Among them 37 respondents have responded.

Results & Discussion

Lack of proper project management lead construction projects to face with delays in completion, unavoidable cost overrun and bad experience in efficient qualities (Fashina et al., 2020). According to Patil (2016), undefined goals, changes in scopes, improper risk management, impossible deadlines make it difficult in completing the project as per the agreed schedule. Increased contract volumes, globalization of markets, new regulatory requirements, and project complexity have all served to emphasize the need of good contract and project management. Over the past few decades, the Sri Lankan government has carried out a significant number of infrastructure development projects. Some of them encountered scope modifications, delays, cost overruns, disagreements, and social backlash. This led to higher prices, a longer social and environmental effect during development that prevented the general public from using infrastructure facilities for years, and a lower utilization of domestic and international resources.

Lack of effective project management and contract management abilities, as well as internal conflict resolution within Project Management Units, were major contributing reasons. (Guide to Project Management and Contract Management (GPMCM) – New Approach to Improve Efficiency and Effectiveness of Procurement Outcomes | World Bank - New Procurement Framework, n.d.). Furthermore, unclear goals and responsibilities, lack of communication, unprepared team, resistance to change and limited resources are some other barriers which are influencing on successful project implementation (Team, 2016). The results obtained from the questionnaire has been shown below.

According to the literature review it could be identified the barriers which are influencing over effective project management practices. Due to the complexity of construction industry, construction projects are being suffered from material wastage, high fragmentation, poor productivity, time overruns, cost overruns, disputes and conflicts over a long time. Furthermore, construction industry needs to strengthen integration, collaboration,

coordination and communication throughout the construction process and it will result in improving the efficiency and effectiveness of the operations (Hai *et al.*, 2012). Hence these particular facts need to be managed and developed through proper project management practices to ensure the success of construction projects.

According to your opinion what are the major barriers for practicing effective project management in construction industry

37 responses

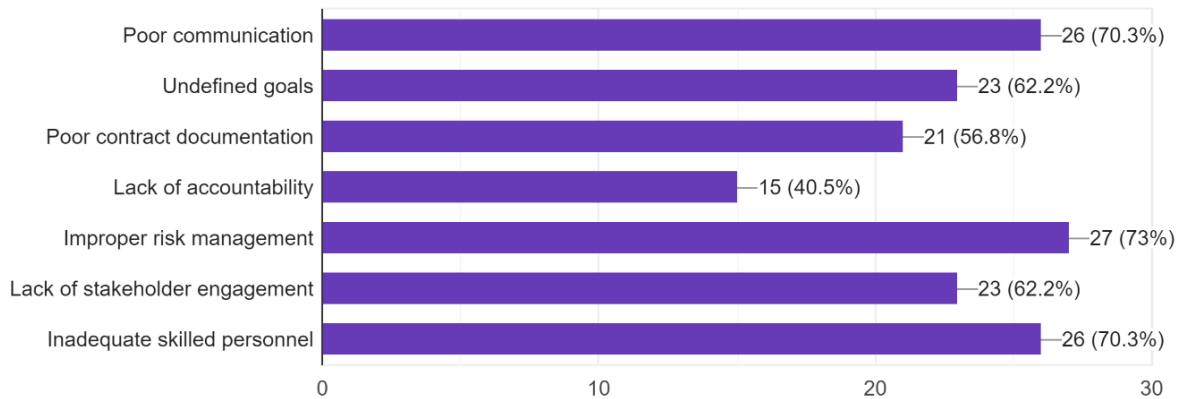


Figure I

Respondents were allowed to select multiple responds for the result shown in figure I and highest number of respondents have responded improper risk management as the major barrier for practicing effective project management in construction industry. Poor communication and inadequate skilled personnel have been selected as the next major barriers by the respondents while the next place has been given to undefined goals and lack of stakeholder engagement. Out of all the respondents least number of respondents have selected lack of accountability as their response. Hence from the above responses it is clear that improper risk management, poor communication and inadequate skilled personnel are major barriers for practicing effective Project Management in construction projects.

What can you say about the implementation of project management practices in construction projects

37 responses

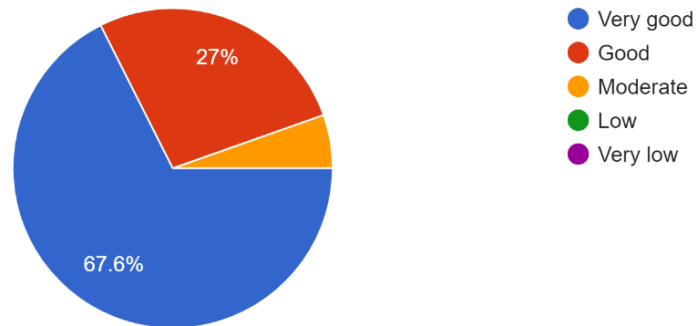


Figure II

Majority of respondents; 67.6% responded that implementation of project management practices is very good in construction projects. 27% responded that it is good while 5.4% agreed that it is moderate.

Project management focuses on delivering the project on time within the agreed budget with the required quality

37 responses

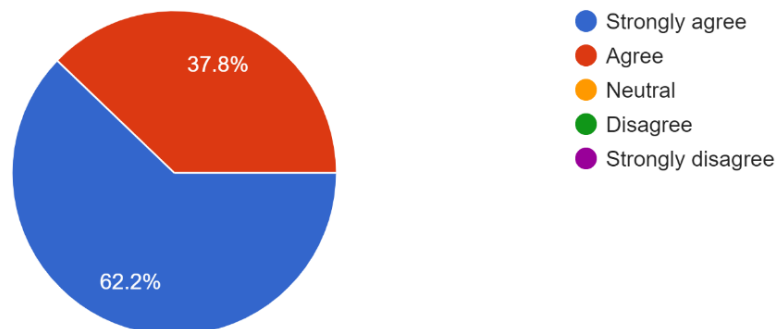


Figure III

As per figure III, majority of the respondents strongly agreed with the fact that Project Management focuses on delivering the project on time within the agreed budget with the required quality and the percentage is 62.2% and the rest of respondents agreed with that.

Stakeholder interaction is vital towards a successful project management

37 responses

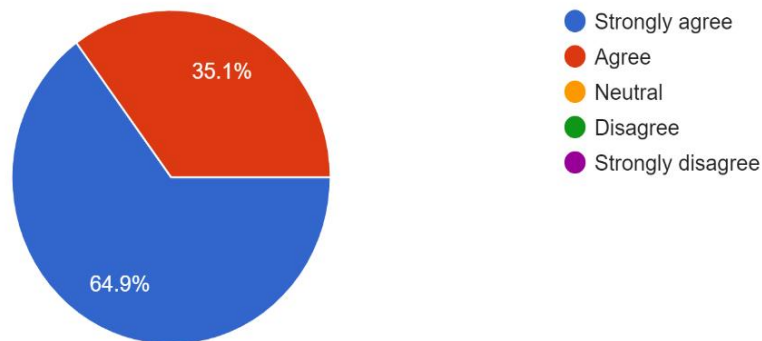


Figure IV

According to figure IV, majority of the respondents strongly agreed with the fact that the stakeholder interaction is vital towards a successful Project Management and the percentage is 64.9% and rest of the respondents agreed with that.

Conflict resolution is an important leadership attribute of a project manager

37 responses

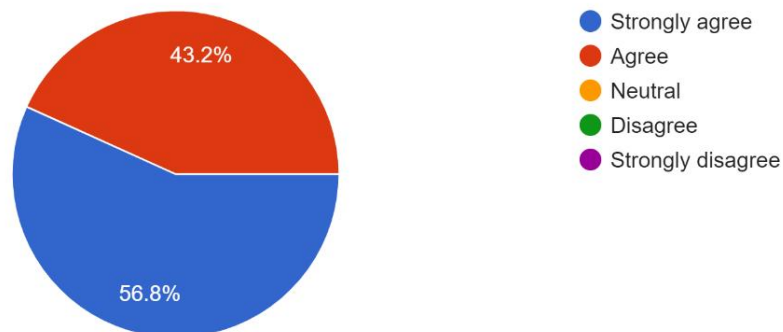


Figure V

Moreover, as shown in figure V, most of the respondents strongly agreed with the matter that conflict resolution is an important leadership attribute of a project manager.

Use of updated softwares in planning would lead to accuracy in project management

37 responses

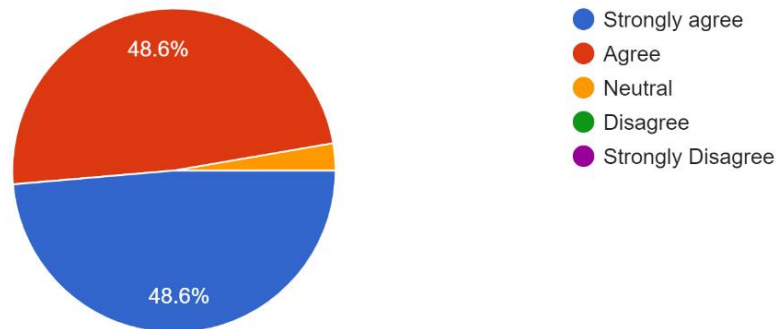


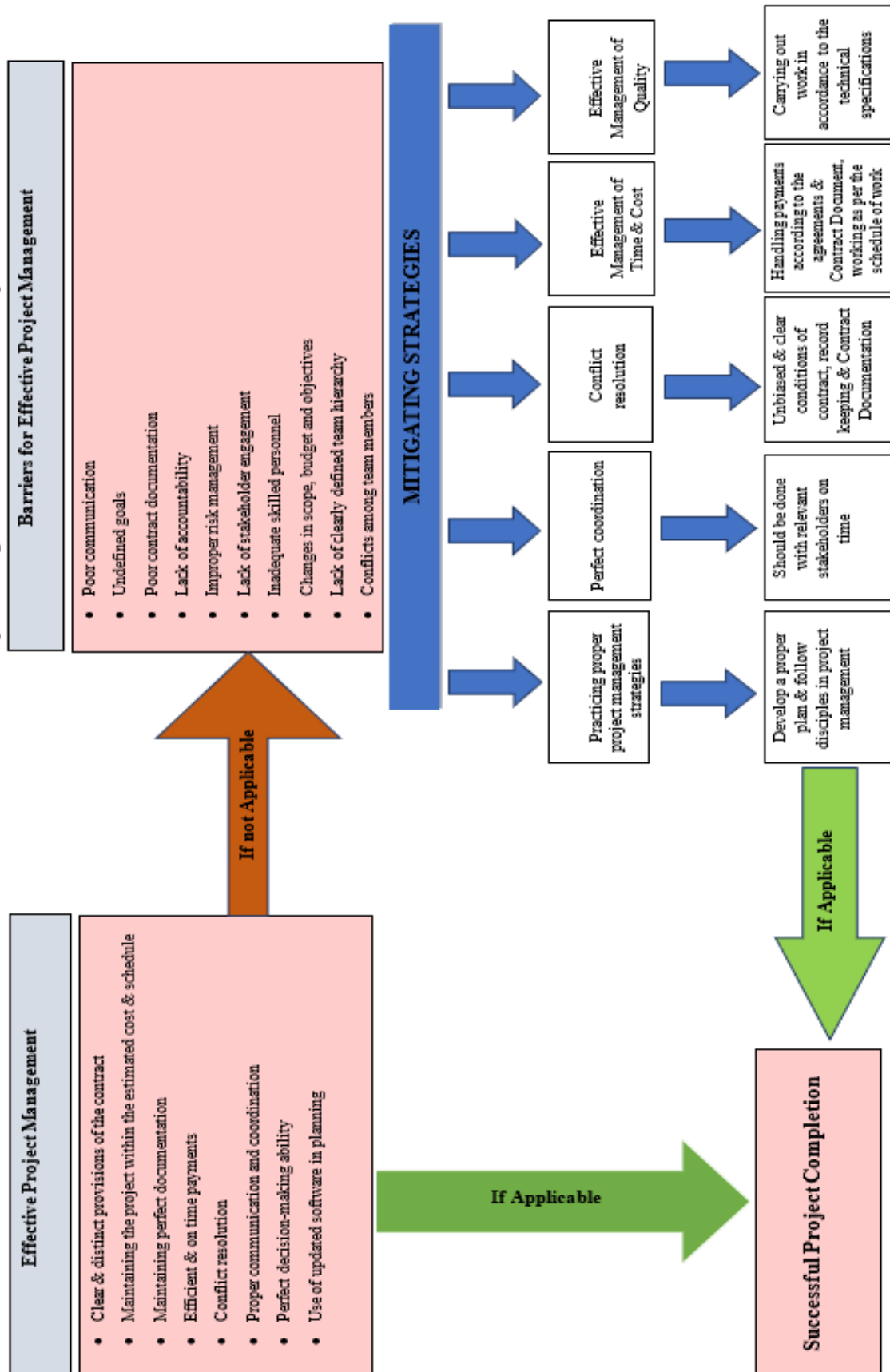
Figure VI

Almost equal number of respondents strongly agreed and agreed to the fact which was asked regarding the use of updated software in planning would lead to accuracy in Project Management.

Furthermore, respondents have further mentioned that the changes in scope, budget and objectives, lack of clearly defined team hierarchy, structure and objectives, lack of commitment by team members, conflicts among team members, competition among team members over positions of authority and power as the factors which influence over practicing effective project management in construction industry.

Thus, the choice of the respondents is justifiable, and it is crucial for project managers to make an attempt to comprehend the skill sets of their project teams and utilize this on the project schedule by giving the tasks, activities, and deadlines for the project the appropriate priority.

Theoretical Framework to Minimize the Barriers of Project Management in Construction Industry



Conclusion and Recommendations

This study has shown the relationship between an effective Project Management and successful delivery of construction projects. Through the literature review of this study it can be concluded that the barriers for the implementation of Project Management practices affect directly on achieving the objectives of construction contracts.

It is fundamental that a proper Project Management is important in construction industry. Therefore, a successful relationship should be developed between the Project Management and successful project completion. Hindrances and root causes for hindrances should be identified in order to find solutions for the unfavorable hindrance factors. The solutions for the hindrance factors have been identified in accordance to the relevant problem.

A framework has been developed as a solution to minimize the effect of barriers affecting on Project Management towards successful construction project completion. It can be concluded further that by implementing the mitigating strategies on the hindrance factors, the project can be led towards the success. Directing an unsuccessful project towards a successful project is a function of Project Management by avoiding the hindrances and implementing mitigating strategies for the hindrances whenever possible.

Introducing a clear mechanism for work performing, systematic documentation, conducting proper supervision and management and record keeping and contract documentation are the strategies which need to be implemented to get rid of hindrance factors of Project Management.

It can be concluded from this study that apart from the major project constraints of time, cost and quality, proper coordination among the parties lead to successful project delivery through proper Project Management practices.

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A CASE-STUDY ON FACTORS INFLUENCING MANAGEMENT OF SOCIAL ISSUES IN RENEWABLE ENERGY PROJECTS IN SRI LANKA

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Abstract

Sustainability of developing renewable energy projects is very important at present global context since scarcity of fossil fuel, air pollution and risk of global warming. Even though there is a huge potential of implementing renewable energy projects in Sri Lanka, implementing new projects was negligible since 2018 owing to social issues. Therefore, this study was conducted to identify the impact of the factors influencing managing social issues effectively in the renewable energy sector. Data were collected using 100 participants in the Renewable Energy industry via a structured questionnaire which contained five-point Likert scale questions. Correlation and multiple linear regression analysis were used to identify the impact of factors associated managing social issues in renewable energy projects. Prior Experience, Mutual Trust and Respect, Budget Allocation, Communication and Management Support were significant factors influencing the intention to manage social issues in renewable energy projects.

Keywords: Renewable Energy, Social Issues, Effectively Manage

Introduction

Renewable energy (RE) utilization has seen major global growth over recent years, and it is motivated by factors consist of emission cut, guarantee of energy supply, and employment within a limit of acceptable economic cost (Moriarty & Honnery, 2020). Accordingly, the entire world will be focused on generating electricity through renewable energy sources and discourage to generate electricity from fossil fuel. Most of the world leaders are already taking steps to completely stop constructing new thermal plants and shut down their existing thermal plants gradually by 2050 (Bruyninckx, 2016)

In Sri Lankan context, National Renewable Energy Laboratory (NREL) data of USA (2003) stated that nearly 5,000 km² was found as an excellent wind potential area in Sri Lanka. Moreover, Sri Lanka receives significant amount of solar radiation across all geographical regions. The Direct Normal Irradiance (DNI) varies between 1,247 kWh/m² to 2,106 kWh/m² (Witharana, 2021).

Even though Sri Lanka shows a significant potential towards Renewable Energy projects, an average of 100MW added to the national grid annually through renewable industry until 2018. Thereafter, implementing and adding new projects to the system almost negligible owing to social issues (Public Utilities Commission of Sri Lanka, 2020).

Hence, it is very important to manage the social impact of the project, in order to meet the define scope within the time and cost limits. Managing the social impact effectively will be one of the key reasons to success or failed of the project (Mišić & Radujković, 2015). Prior

experience would have been the reason for managing social issues in the RE industry in order to build up the mutual trust and honest need to have people like more educated with human spirituals (Reed, et al., 2016). It is required to have an adequate budget for community works and this must identify in the social impact assessment report. Further cultural differences. Proper communication between developer and the project affected person and Management support and involvement may require when there is a critical social issue (Heaner, 2013; Morrow, et al., 2011; Markus, 1981).

Since there was few, empirical research carried to understand the factors influencing management of social issues effectively in renewable energy sector in Sri Lankan context, it became significant to carry out the study in context with valid and reliable instruments to help Sri Lankan RE sector stakeholders to take favorable decisions to overcome the problem of losing more than 500MW during last five-year period due to non-immersing of new renewable energy plants to the national grid (Public Utilities Commission of Sri Lanka, 2020) . Therefore, the objectives of the study were,

- To identify the factors influencing effectively managing the social issues in Renewable Energy Sector.
- To identify the impact of the factors influencing effectively managing the social issues in Renewable Energy Sector

Methodology

Data were collected by using selected 100 respondents through convenience sampling which contained stakeholders of renewable energy industry in Sri Lanka. According to theoretical analysis and the critical review, a structured questionnaire was developed which contained five-point Likert scale questions where 1 stand for strongly disagree/very low and 5 stands for strongly agree/very high effect on the statements in order to measure five exploratory variables (prior experience, mutual trust and respect, budget allocation, communication skills, and management support) and the response variable of intention to manage social issues. Correlation and multiple linear regression were carried out using SPSS version 26 in order to check below hypothesis based on research objectives.

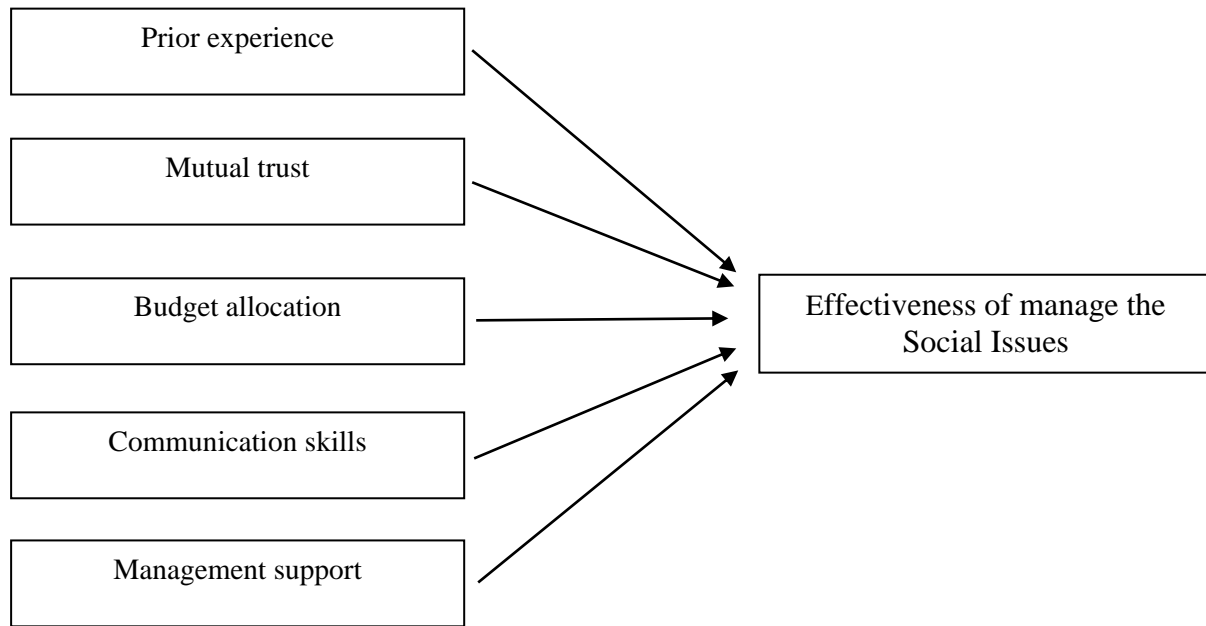


Figure 1. Conceptual framework

H₁₁: Prior experience is influencing for effectiveness of manage the Social Issues in the Renewable Energy Project of Sri Lanka.

H₁₂: Mutual trust and respect of both parties is influencing for effectiveness of manage Social Issues in the Renewable Energy Industry in Sri Lanka.

H₁₃: Budget allocation is not influencing for effectiveness of manage Social Issues in the Renewable Energy Industry in Sri Lanka

H₁₄: Communication skills is influencing for effectiveness of manage Social Issues in the Renewable Energy Industry in Sri Lanka

H₁₅: Management support is influencing for effectiveness of manage Social Issues in the Renewable Energy Industry in Sri Lanka.

Results

According to descriptive results of exploratory variables and the response variable mean values of above 3.0 reveals that respondents believe that all five independent variables are very important to consider when managing social issues effectively (Table 1).

Table 1. Mean values of variables

	N	Mean
Prior Experience	100	4.153
Mutual Trust and Respect	100	4.230
Budget Allocation	100	4.140
Communication	100	4.126
Management Support	100	3.763
Manage Social Issues	100	4.095

Correlation analysis was conducted to identify the linear relationship between variables. Results of the above-mentioned test are given in below.

Table 2. Correlation Matrix

		Manage Social Issues
Prior Experience	Pearson Correlation	0.769
	Sig. (2-tailed)	0.000**
Mutual Trust and Respect	Pearson Correlation	0.830
	Sig. (2-tailed)	0.000**
Budget Allocation	Pearson Correlation	0.820
	Sig. (2-tailed)	0.000**
Communication	Pearson Correlation	0.785
	Sig. (2-tailed)	0.000**
Management Support	Pearson Correlation	0.756
	Sig. (2-tailed)	0.000**

***Significant at 5% level of significance*

The results of the correlation analysis imply that all five independent variables show strong positive correlations with the response variable as all correlation coefficient values are greater than 0.75. Further, sig-values of less than 0.05 indicates that all relationships are significant at 5% level of significance (Table 2).

Table 3. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.950	0.902	0.897	0.1678

Predictors: (Constant), Management Support, Prior Experience, Mutual Trust and Respect, Communication, Budget Allocation

Table 3 shows the amount of variabilities explained by the model. Adjusted R square of 0.897 implies that out of total variabilities 89.7% of variabilities are explained by the regression model.

Table 4. ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	24.385	5	4.877	173.213	.000**
	Residual	2.647	94	0.028		
	Total	27.032	99			

***Significant at 5% level of significance*

Dependent Variable: Manage Social Issues

Predictors: (Constant), Management Support, Prior Experience, Mutual Trust and Respect, Communication, Budget Allocation

The result of the ANOVA table shows the adequacy of the model. According to sig-value of less than 0.05 reveals that the regression model is adequate at 5% level of significance.

Table 5. Coefficients

	Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.
(Constant)	0.559	0.130		4.293	0.000**
Prior Experience	0.182	0.031	0.264	5.822	0.000**
Mutual Trust and Respect	0.236	0.039	0.312	5.985	0.000**
Budget Allocation	0.131	0.039	0.186	3.380	0.001**
Communication	0.182	0.047	0.195	3.882	0.000**
Management Support	0.131	0.035	0.178	3.700	0.000**

***Significant at 5% level of significance*

Dependent Variable: Manage Social Issues

Predictors: (Constant), Management Support, Prior Experience, Mutual Trust and Respect, Communication, Budget Allocation

Table 5 shows regression coefficients of independent variables. Regression coefficients of 0.182, 0.236, 0.131, 0.182 and 0.131 of Prior Experience, Mutual Trust and Respect, Budget Allocation, Communication and Management Support reveal that there is a positive impact of all five exploratory variables on intention to manage social issues whilst Mutual Trust and Respect is showing the highest impact. Moreover, the sig-value of all five independent variables are less than 0.05. It implies that all five independent variables show significant impact on managing social issues in RE projects. Therefore, these results support all five (H₁₁, H₁₂, H₁₃, H₁₄ and H₁₅) research hypothesis.

Discussion

The findings of this study showed that Prior Experience, Mutual Trust and Respect, Budget Allocation, Communication and Management Support create a significant impact on managing social issues in Renewable Energy projects. Several papers were published about the social acceptance of Renewable energy innovation. The study conducted by Haslam, et al. (2017) described that requirement of more active social acceptance. This study also discussed about how important mutual trust and respect are to solve social issues; hence this research study is strengthening the results of that previous study. So far, most of the papers discussed about the European and western countries specific matters about the social acceptance of RE industry. Therefore, this research study strengthens the similar studies with different geographic scenario. Most of the papers have not been highlighted about the management support of social barriers, this dissimilarity is because of the highlighted projects were funded by the financial institutes or pension funds whereas most of the RE projects is funded in Sri Lanka by private investors. Hence it is good to cover that part of the factor which really influence to manage social issues effectively.

Conclusions and Recommendations

The study showed that there is a significant impact of all selected five independent variables on the intention to manage social issues effectively in Sri Lankan Renewable Energy Sector. This study is very significant since the present power and economic crisis mainly because of non-emerging renewable projects on time. Social barriers one of the main reasons of non-set up of new RE plants in Sri Lanka. Therefore, it is advice to recruited professionally qualified staff to handle social barriers in patience and professional way.

Quantitative methods were used for this study; however, qualitative approach or mix-method approach would be recommended for future researches as it would generate better and more valuable results.

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SOCIAL SCIENCE

THE MODERATING ROLE OF HONOUR IN RESPONSES TO SOCIAL EXCLUSION

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Abstract

Honour values have been found to shape emotional and behavioural responses to negative social interactions. The current study investigated whether the relationship closeness has a significant effect on responses to exclusion and whether honour plays a moderating role in these responses. One hundred eighty-three participants (28 male; 155 female; $M_{age} = 19.7$, $SD_{age} = 2.48$) living in the UK were randomly assigned to one of three conditions (close-other exclusion, stranger exclusion, control), and emotional responses and behavioural intentions were measured. Significant differences were found between the excluded groups and the control group however no significant differences were found between the close-other and stranger group. Feminine, masculine, and integrity honour played a moderating role in some responses. The findings suggest that honour serves a protective function in situations of exclusion where it can act as a buffer against the pain of negative social interactions.

Keywords: Behaviour Intentions, Culture, Emotions, Honour, Social Exclusion

Introduction

The need to belong is something individuals give great importance to, therefore being socially excluded can be very hurtful (Baumeister & Leary, 1995; Williams, 2007; Twenge et al., 2007). A growing body of research has examined the cultural factors that affect responses to exclusion (Pfundmair et al., 2015). Honour is cultural dimension that has been examined in studies related to social behaviour (Cross et al., 2013; Rodriguez Mosquera et al., 2008). Honour involves upholding reputation, moral integrity, status, masculinity, and femininity (Baldry et al., 2013).

In honour cultures, often social interdependence (SI) is high (Uskul & Over, 2017). Individuals from Turkey and India have shown to be less negatively affected by exclusion than individuals from the United States and Germany (Pfundmair et al., 2015). Markus and Kitayama (1991) argue that this may be due to the understanding that individuals from collectivistic backgrounds do not perceive exclusion to be threatening as it does not affect their interdependent self which is determined by their connections with others rather than their unique social standing. Alternatively, another prediction is that those who are higher in SI will be more negatively affected by exclusion due to the high importance of social bonds (Triandis, 1995).

Past contradictory findings can be attested to one crucial limitation in studies, which is that they failed to consider the relationship between the excluder and the excluded. Responses toward exclusion by in-group members and out-group may vary in cultures where values are deeply embedded in the importance of social bonds. The present study incorporated close-other and stranger conditions, with two predictions: *H1*. Participants in the exclusion conditions would be more negatively affected than those in the control. *H2*. Participants in the close-other condition would be more negatively affected than those in the stranger

condition. Exploratory analyses were conducted to investigate the effects on behavioural responses and the moderating role of honour.

Methodology

Participants

A priori power analysis using G*Power version 3.1. (Faul et al., 2007) revealed that the minimum sample size required for linear multiple regression analyses with four predictors, 95% power, with small to medium effect, was $N = 124$. Two hundred and seven undergraduate students were recruited from a UK university. After eliminating failed attention checks, the sample consisted of 183 participants (28 male, 155 female; $M = 19.67$, $SD = 2.48$).

Design and Procedure

The study used a one-way experimental design with three levels (strangers' exclusion vs close-others exclusion vs inclusion control). To manipulate exclusion, three descriptive vignettes were used. The dependent variables (DVs) were emotional responses (need satisfaction) and behavioural intentions (prosocial, antisocial, and avoidant behaviour). The moderator variable was honour. The study was presented as a Qualtrics self-report survey. Data was analysed using SPSS version 25.0 and PROCESS macro version 3.3 (Hayes, 2013). After providing informed consent and demographics, participants were randomly allocated to one of three conditions using the Qualtrics randomiser. Following the vignette, participants completed the DV measures.

Materials

Need Satisfaction

The need satisfaction scale included 12 items in total with subscales of belonging ($\alpha = .95$), self-esteem ($\alpha = .94$), meaningful existence ($\alpha = .90$) and control ($\alpha = .82$; overall scale $\alpha = .96$). For each question, participants were asked to rate their experienced feelings during the imagined situation on 7-point scales.

Behavioural Intentions

Participants completed a 4-item scale that measured prosocial, antisocial, and avoidant behaviour intentions on 7-point scales (e.g., "I would have socialised with other people").

Honour

The honour concerns scale by Rodriguez Mosquera et al. (2002) consists of 24 items with sub-scales of feminine honour ($\alpha = .85$), masculine honour ($\alpha = .74$), and family honour ($\alpha = .77$), integrity ($\alpha = .75$; overall scale $\alpha = .90$). The scale included items such as "To maintain my honour, I should be loyal to my family, no matter the circumstances".

Results

The Role of Relationship Closeness

To assess the main effects of exclusion condition on need satisfaction and behavioural intentions, one-way MANOVA and one-way ANOVA were conducted to examine the overall multivariate effect on the DVs, and the univariate effects for each subscale. On all measures

except prosocial behaviour intentions, significant differences were found between the excluded group and the control group (see Table 1), however no significant differences found between the close-other group and stranger group for all DVs (all p 's > .05).

Table 1

Means, Standard Deviations, and One-way Analyses of Variance in Responses to Social Exclusion in Excluded groups versus Control group

Measure	Excluded Group				Non-excluded Group		$F(2, 180)$	η^2
	Close other		Stranger		Control			
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>		
Need Satisfaction	-	-	-	-	-	-	47.03**	.52
Belonging	1.86	.67	1.88	.78	4.42	.59		
Meaningful	2.12	.73	2.09	.87	4.09	.57		
Existence								
Self-esteem	1.73	.61	1.76	.86	3.71	.76		
Control	1.93	.66	1.99	.83	3.36	.56		
Behavioural	-	-	-	-	-	-	24.9**	.30
Intentions								
Antisocial	2.55	1.52	2.47	1.35	3.42	1.39		
Avoidant	4.84	1.56	5.33	1.19	2.47	1.32		
Prosocial Other	4.84	1.48	5.05	1.36	4.66	1.56	1.09	.012

Note: Correlation is significant at the $p < .01$ level (**). Correlation is significant at the $p < .05$ level (*)

The Moderating Role of Honour

To assess the moderation effects of honour on the DVs, multiple linear regression analyses were conducted using each subscale of honour and the DVs using the enter method.

Excluded vs Non-Excluded Group Regression Analyses

Feminine Honour. There was a significant moderation effect of feminine honour on belonging ($F(3,179) = 201.1, p < .001, R^2 = .771$), control ($F(3,179) = 60.8, p < .001, R^2 = .51$), self-esteem ($F(3,179) = 85.8, p < .001, R^2 = .590$) and meaningful existence ($F(3,179) = 105, p < .001, R^2 = .638$). In the excluded group, higher feminine honour endorsers reported higher need satisfaction than lower endorsers (Figure 1).

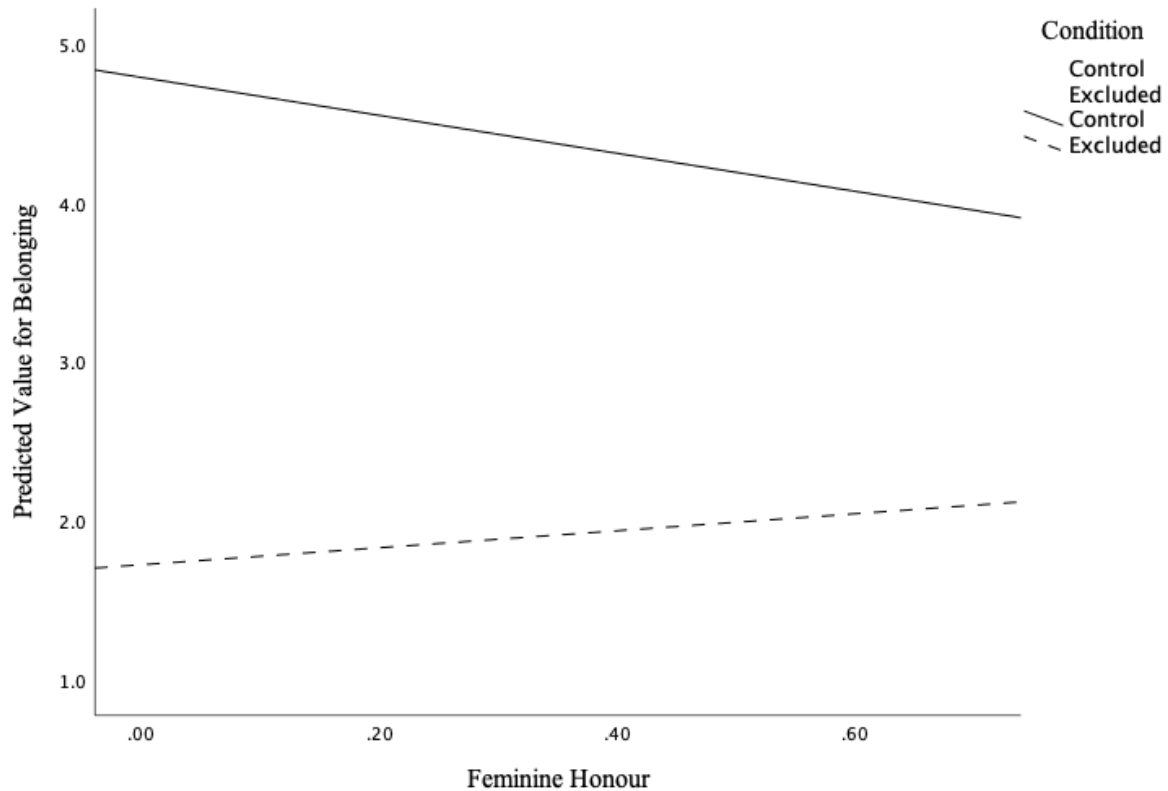


Figure 1 : Interaction between Exclusion Condition and Feminine Honour on Belonging

Masculine Honour. Masculine honour showed a significant moderating effect on belonging ($F(3,179) = 203, p < .001, R^2 = .772$), self-esteem ($F(3,179) = 105.6, p < .001, R^2 = .639$), and meaningful existence ($F(3,179) = 107.3, p < .001, R^2 = .643$). The moderation patterns found were like those shown by the moderation effects of feminine honour in the excluded and control group. There were no significant moderation effects of masculine honour for control ($p = .103$), prosocial ($p = .112$), antisocial ($p = .298$), and avoidant ($p = .057$) intentions.

Family Honour. Family honour played a significant moderating role for meaningful existence ($F(3,179) = 105.2, p < .001, R^2 = .638$). The moderation patterns found were like those shown by feminine and masculine honour. There were no significant moderation effects of family honour for belonging ($p = .253$), self-esteem ($p = 2.88$), control ($p = .212$), and prosocial ($p = .620$), antisocial ($p = .092$), and avoidant ($p = .834$) intentions.

Integrity Honour. Integrity honour only showed a significant moderating effect on avoidant intentions, ($F(3,179) = 45.1, p < .001, R^2 = .431$) Higher endorsers of integrity honour reported lower avoidant behavioural intentions in the excluded group, and this relationship was stronger in the control group (Figure 2). There were no significant moderation effects of integrity honour for need satisfaction (all p 's $> .05$), prosocial, and antisocial intentions ($p = .778$).

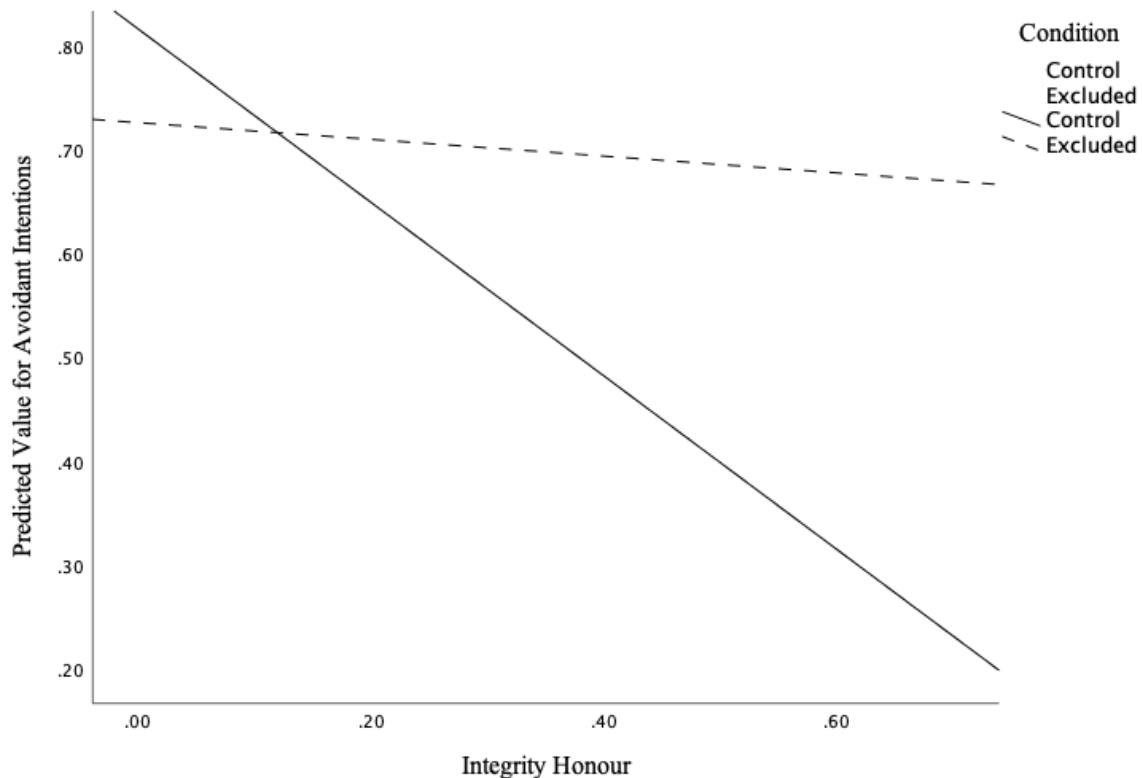


Figure 2 : Interaction between Exclusion Condition and Integrity Honour on Avoidant Behaviour

Close-other vs Stranger Group Regression Analyses

Feminine Honour. To examine the moderation effects of honour between the close-other group versus the stranger group, regression analyses were conducted using all DVs. For feminine honour, there were no significant moderation effects need satisfaction (all p 's > .05), and prosocial ($p = .765$), antisocial ($p = .081$), and avoidant ($p = .186$) intentions.

Masculine Honour. Masculine honour showed a significant moderating effect on antisocial behaviour intentions, $F(3,118) = 3.90$, $p = .011$, $R^2 = .090$. In the stranger group, higher endorsers of masculine honour reported higher antisocial behaviour intentions compared to lower masculine honour endorsers. This relationship was weaker in the close-other group (see Figure 3). There were no significant moderation effects of masculine honour for need satisfaction (all p 's > .05), prosocial ($p = .862$), and avoidant ($p = .542$) intentions.

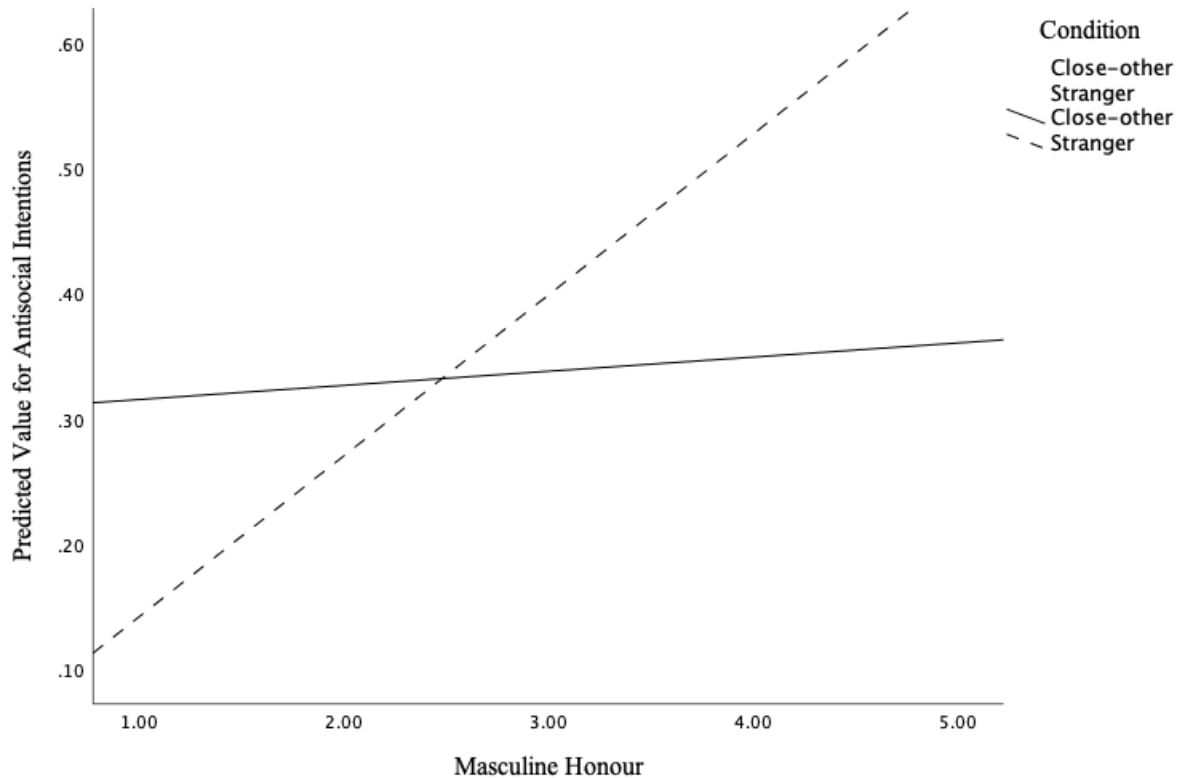


Figure 3 : *Interaction between Exclusion Condition and Masculine Honour on Antisocial Intentions*

Family Honour. There were no significant moderation effects of family honour for any of the DVs: need satisfaction (all p 's > .05), prosocial ($p = .790$), antisocial ($p = .148$) and avoidant ($p = .138$) intentions.

Integrity Honour. There were no significant moderation effects of integrity honour for any of the DVs: need satisfaction (all p 's > .05), prosocial ($p = .373$), antisocial ($p = .454$) and avoidant ($p = .123$) intentions.

Discussion

The present study examined the emotional responses and behavioural response intentions toward social exclusion by strangers and by close others moderated by honour. The results showed that relationship closeness alone did not have a significant effect on the emotional and behavioural responses to social exclusion. However, participants in the excluded groups reported significantly lower scores of need satisfaction than the control group. It was also found that some types of honour played a moderating role. Feminine honour played a significant role in moderating the effects on need satisfaction when examining the excluded vs non-excluded groups, while masculine honour played a moderating role for all emotional responses except control. This suggests that honour plays a protective role, like that of SI during exclusion situations.

Across both groups, there was a positive relationship between masculine honour and antisocial behaviour intentions. This can be explained by the role of anger in threats to male honour (Cohen & Nisbett, 1997). Retaliatory aggression due to high importance paid to honour concerns is common in honour cultures (Leung & Cohen, 2011). Offences often result

intense emotions such as anger and shame in honour cultures and is linked to the importance of reputation (Pitt-Rivers, 1977). Such cultures emphasize toughness in public behaviour as traits of manhood (Gilmore, 1990). Therefore, submitting to public humiliation may be seen as a loss of honour. Refusal of submitting to public humiliation can be shown through antisocial behaviour. It was also found that participants who scored higher on integrity honour were less likely to avoid than participants who scored lower. Varying views exist on the role of personal integrity in honour maintenance (e.g., Stewart, 1994). Items in the integrity subscale were related to qualities such as not betraying others and doing the right thing which can be considered less characteristic of the honour code and more of a moral code.

There are a few notable limitations of the study. Firstly, vignettes produce a snapshot of what might be a larger, more complex situation which gives participants distance to interpret the situation. However, where this snapshot does not provide sufficient information, participants may answer questions with an ‘it depends’ response. Secondly, the sample of the study was university students who are known to embody special demographic characteristics (i.e., Western, educated, industrialised, rich, and democratic; Henrich et al., 2010). Research has shown that members of United Kingdom display characteristics of a dignity culture (e.g., Gul & Schuster, 2020; Gul & Uskul, 2019). Nonetheless, the study measured honour as an individual difference variable.

Conclusions and Recommendations

In conclusion, this present study was one of the first to explore relationship closeness in a social exclusion situation in the context of honour. The findings showed that relationship closeness did not play a significant role in the effects of social exclusion outside the context of honour. However, in the context of culture, honour plays a protective role in exclusion situations. The findings have potential implications for understanding cultural differences in antisocial behaviour, prosocial behaviour, and emotion management during negative situations. Future research should use more realistic manipulations and assess actual behavioural responses. Studies should also include more contextual cues in the vignettes such as the nature of the setting (public vs private) and explore the mediating role of anger in responses to negative situations in honour contexts.

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THE ACCOMMODATION OF SPECIAL EDUCATIONAL NEEDS IN INTERNATIONAL SCHOOLS IN SRI LANKA

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Abstract

Though a fundamental right, education is not freely accessible to all Sri Lankan children alike. This is more so in the case of children with special learning needs. The question arose as to how well children with special learning needs were accommodated in the Sri Lankan educational system. This study aimed to find out if and how well SEN children are accommodated in international schools which are privately owned and are thus assumed to have access to greater resources than state-owned schools due to the lack of financial constraints. A total of six teachers participated in semi-structured interviews. Thematic analysis revealed three main themes: efforts to include SEN children into a regular international school classroom, obstructions to including SEN children into a regular international school classroom and areas for further research. In conclusion, SEN students were accommodated; the degree to which, however, varied. It has also been made evident that the educational system in Sri Lanka could benefit from a more inclusive system which facilitates the integration of SEN children into regular classrooms.

Keywords: Special Needs, International schools, Colombo, Sri Lanka, Special Educational Needs

Introduction

The presence of special educational needs (SEN) children in the educational system is undeniable, and a subject of growing concern throughout the years. Research has shown that the educational system, though accommodating in the West, these adjustments are yet to be seen in the East where there is just as great a need (Douglas et al., 2015). Though the need is great, there is a hesitance to admit to it and therefore invest in it. This has been attributed to multiple factors such as insufficient funds to allocate into the educational sector, along with a local culture that renders most people without a voice when it comes to SEN education.

As can be seen from the economic crisis that hit the local Sri Lankan economy in early 2022, the learning sector has not been spared. Prior to the crisis, the Easter bombings and COVID 19 contributed towards the sharp decline in learning conditions in the country (Anandakugan, 2021; Singh, 2019; Das, 2022; Dayasiri et al., 2022). The children were forced to stay at home with no proper means of being educated, their measures were reactive and not proactive, they were figuring it out as they went. This put a strain on the country. Additionally, there was a scarcity of medicine that hit at the same time. This suggested that if one were not able to contribute towards the economy, they would eventually become a burden; public healthcare would be insufficient in the future.

According to research carried out by Muttiah et al. (2016), SEN children were also asked to stop schooling after the age of 14, which was right before their O Levels, wherein they were not allowed to sit any major exams that could help with their further education which would

eventually help them get a job and start contributing towards the economy. This, coupled with the dwindling quality of the teaching workforce, along with the inadequacy of SEN resources such as therapists and lesson aides poses a very real threat to the future wellbeing of SEN children in the educational system of Sri Lanka.

The current study served to highlight the gap between what standards should be for these SEN children, versus what it actually is. This is done with the hope that educational reforms will be promoted in this nation, so that SEN children would have a better future.

Methodology

Participants

Teachers who taught in international schools were selected through judgemental sampling. The sample consisted of six female teachers who taught within the urban outskirts of Colombo. Inclusion criteria required them to be above the age of eighteen, working for a minimum of one year at an international school in or within the suburban outskirts of Colombo, Sri Lanka.

Data Collection

This study was reviewed and approved by the Cardiff School of Sport and Health Sciences at Cardiff Metropolitan, UK. A total of six female teachers volunteered as participants from five different schools within the suburban limits of Colombo responded and took part in semi structured interviews over the online platform, Zoom. Each participant was interviewed once, and these interviews lasted for a duration of 20 to 45 minutes. Four out of the six participants were teachers in the primary school and the remaining two taught grades up to Ordinary Levels.

Method of Analysis

Once the interviews were transcribed, the statements made by the participants were analysed individually so as to pick up themes from their accounts of how SEN children are catered to at the school they work at, this process included analysing their transcripts line by line. For this purpose, a hybrid approach which employed both inductive and deductive coding was used. Each transcribed sentence was inspected for underlying themes. Once individual codes and themes were identified, they were all combined into one table which served as the overall thematic analysis for all six interviews.

Results

The following themes and subthemes emerged in the study (see Table 1).

Table 1

Efforts to include SEN children into a regular international school classroom	Obstructions to including SEN children in a regular international school classroom	Areas for further research
Physical environment conducive to learning	Recruitment practises which overlook requirement of SEN teaching qualifications	Relationship between COVID and worsening learning needs
Equipment of teachers to handle SEN children	Lack of teacher experience and knowledge to educate SEN children	Relationship between age and worsening learning needs
SEN integration culture	Restriction from sitting higher level exams due to lack of learning support	Relationship between local cultural stigma and SEN accommodation
Enabling SEN children to finish school without dropping out	Integrating SEN children into mainstream is of low priority	

1. Efforts to include SEN children into a regular international school classroom

1.1 Physical environment conducive to learning

Five out of six participants described the physical environment of their school as spacious, bright, and comprised of different equipment to aid in the delivery of interactive lessons. The remaining participant described the environment as not having ample space, but sufficient ventilation to compensate for it.

1.2 Equipment of teachers to handle SEN children

This theme was present in one participant, whereas other participants attested to there being training available for staff, although it was not in the nature of SEN accommodation.

1.3 SEN integration culture

Five out of six participants reported a predominantly positive environment which fostered a culture of inclusion, resulting in the creation of a closely knit support system for the SEN children who attended the school.

1.4 Enabling SEN children to finish school without dropping out

Learning support was available until the senior classes in two out of five schools. This would enable SEN children to continue until the end of their school years, eliminating the need to drop out due to a lack of teaching assistance. A contrasting theme can be found in section 2.3 where assistance was offered only up to the end of primary schooling years.

2. Obstructions to including SEN children in a regular international school classroom

2.1 Recruitment practises which overlook requirement of SEN teaching qualifications

The procedure of recruitment was inquired after, to which all six participants reported not being asked for SEN qualifications upon being recruited. This excluded teachers who would have been recruited to work in learning support units present within these schools.

2.2 Lack of teacher experience and knowledge to educate SEN children

In addition to not having a mandatory background in SEN and designated staff who specifically deal with SEN children, resources such as training was not offered to staff. This was the case reported in four of the six teachers who partook in the study.

2.3 Restriction from sitting higher level exams due to lack of learning support

Three out of five participants reported that even in schools where there were learning support units, not all of them went up to the senior grades.

2.4 Integrating SEN children into mainstream education being a very low priority

All six participants attested to observing the presence of SEN children who fell under the lesser spectrum within their regular classrooms. They also commented on the low numbers of children with special needs in regular classrooms. Two out of six participants also went on to express the reservations the management of the school they worked in held with regards to integrating SEN children into mainstream education, resulting in the rather low numbers of students with special needs in relation to the comparatively average peers.

3. Areas for further research

3.1 Relationship between COVID and worsening learning needs

COVID was one of the external variables participants attributed to the increase of SEN cases throughout the past few years.

3.2 Relationship between age and worsening learning needs

Participants drew attention to the worsening needs of all school-going children, noting that they seem to get worse with age.

3.3 Relationship between local cultural stigma and SEN accommodation

When asked about the willingness of the school management to accommodate the learning needs of SEN children in a regular classroom, there was evidence to suggest that cultural stigmatisation may have a role to play in determining how well special needs are catered to within a regular international school classroom.

Discussion

The environment was very conducive for average learners; however, it posed the question as to whether it could suit the kinaesthetic learning style of a SEN student. It was proven that local international schools did not have a lot going on in terms of outdoor environments, thus limiting diversity in learning environments which may cause monotony, especially in the case of students who struggle to focus on lessons. A very small presence of SEN children was observed from the current sample, which may be owing to factors mentioned above as mentioned in previous studies by Ketheeswaran (2021) and Abeywickrama et al. (2013), which highlighted the lack of appropriate teaching resources needed to accommodate SEN children in a regular classroom.

It was also observed that certain schools invested in the quality of the teaching force with regards to accommodating SEN children. This came in the form of training, additional personnel and teaching aides. Two out of the five schools represented in this study offered learning support for SEN children up to Ordinary and Advanced Level Examinations. This can be said to be an improvement on the situation which was spoken about earlier (Arunatilake & Abayasekara, 2017).

Future research recommendations

During the conduction of this study, certain factors that may have contributed to the aggravation of existing learning needs came to light. The first of which was COVID and the impact it has had on SEN children, wherein certain needs could not be addressed due the distance learning. It was also an entirely new concept which took students time to adjust to.

The aspect of culture was also brought up when asked about why participants were unable to meet the needs of SEN children despite their working in schools which, by all reason, should have access to resources necessary. Stigma surrounding SEN children was shown to be prevalent amongst parents, wherein they were not too keen on having their relatively normal children mingle with those who were considered not so normal. This has made the management of schools exercise caution when it comes to accommodating SEN children in regular classrooms.

Limitations

Interviews can be said to always carry an element of bias, especially in the participant's account of facts and events. In an attempt to avoid this, open ended questions which were not leading in nature were used. Since the interviews all took place online, the interviewer also made sure they were visible at all times, though participants were not required to keep their cameras on, this was done in order to maintain transparency. Though it may have put the participants at ease, it left much up to the careful interpretation of the interviewer. Additionally, there would have been more depth and diversity in the study findings if the participants had been a mixture of both male and female teachers.

Conclusion

In conclusion, it can be seen from the study above, that SEN education has ample room for improvement in Sri Lanka. The research findings highlight the difference in resource allocation when it comes to SEN children in the international schools situated within Colombo in comparison to their average peers, in terms of physical environment, lesson material and teaching personnel. It has also highlighted the need to ensure all children's right to education until the sitting of their Ordinary and Advanced Levels are met, with as little discrimination as possible. The local culture, which has influenced the unfair discrimination of SEN children is outdated and serves as a hindrance for the growth of the future generation of this country. In conclusion, it is of vital importance that a change in the local educational system takes place, enabling the growth of the Sri Lankan economy.

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THE RELATIONSHIP BETWEEN PERSONALITY TRAITS AND STRESS OF TEACHERS WORKING FROM HOME DUE TO COVID-19 IN SRI LANKA

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Abstract

The current study examined the role of the big five personality traits (extraversion, openness, neuroticism, agreeableness, and conscientiousness) on the perceived stress levels of teachers who worked remotely during COVID-19, in Sri Lanka. An online survey was utilized to collect data from 80 Sri Lankan teachers (15 male; 65 female) between the ages of 18 years to 60 years who had taught using online platforms during the pandemic. The scales used were the Big Five Inventory-10 and the Perceived Stress Scale. Multiple linear regression was used to examine the impact of personality traits on perceived stress. The results revealed neuroticism was the strongest predictor ($\beta = 0.508, p < .001$) of perceived stress of teachers. Additionally, it was found that agreeableness was also associated with perceived stress levels ($\beta = -.295, p < .05$). These results reveal that particular personality traits of a teacher influence their perceived stress level.

Keywords: COVID-19, Teachers, Personality traits, Stress

Introduction

One of the most significant issues that are still prevalent in the 21st century is the coronavirus disease, often known as COVID-19 (Agba et al., 2020). Due to the environmental and social changes caused by COVID-19 teachers experienced increased levels of stress (Raaper & Brown, 2020). Lack of proficiency with contemporary tools and technology has presented various difficulties for teachers, students, and several staff members (Erandi et al., 2020). Stress is one of the most significant contributors to declines in mental health, particularly among educators. This diminishes teachers' self-efficacy, increase levels of burnout, lower their work satisfaction, and increase teacher attrition, this, in turn, can reduce the quality of educating pupils (Betoret, 2009). The way a person experiences life and reacts to difficult situations is greatly influenced by their personality (McCrae & Costa, 2003). According to the five-factor model, personality is defined in terms of the five fundamental qualities neuroticism, extraversion, openness, agreeableness, and conscientiousness (Abbasi, 2016). The existing literature demonstrates a strong association between certain personality traits and stress perception, but only limited studies have been conducted addressing COVID-19 and teachers working remotely. Therefore, the present study aimed to investigate how teachers' personality traits influenced their level of perceived stress whilst teaching online during this new phenomenon.

Taking into account the existing literature, three hypotheses were derived:

H₁ - Neuroticism significantly, and positively predicts the perceived stress level experienced by teachers during the COVID-19 pandemic.

H₂ - Conscientiousness significantly, and negatively predicts the level of perceived stress experienced by teachers during the COVID-19 pandemic.

H₃ - The trait extraversion significantly predicts the level of perceived stress experienced by teachers during the COVID-19 pandemic.

Methodology

Sample and Design

A quantitative, cross-sectional study design was utilized. Eighty participants were recruited using volunteer sampling and the survey was advertised on social media. The inclusion criteria were that teachers had to be over the age of 18 years, residing and teaching primary grades online remotely in Sri Lanka during the COVID-19 pandemic. The participants' educational qualifications ranged from a high school diploma to a master's degree. The majority of the participants 72% (n = 61) were 18 years to 29 years of age, and most had a 1-2 years of work experience. The survey was presented online on Qualtrics.

Measures

Firstly, a demographic questionnaire was utilized to gather basic demographic information about the participants. The questions were pertaining to participants' gender, age, years of work experience as a teacher, and academic qualifications.

The Big Five Inventory (BFI-10), which consists of 10 items to gauge the big five personality characteristics, was the chosen method of measuring the independent variables which consisted of the following traits: extraversion ($\alpha = 0.71$), openness ($\alpha = 0.59$), neuroticism ($\alpha = 0.78$), agreeableness ($\alpha = 0.71$), and conscientiousness ($\alpha = 0.74$; overall $\alpha = 0.74$). The BFI has strong validity and reliability (John & Srivastava, 1999).

The Perceived Stress Scale (PSS) developed by Sheldon Cohen was used to assess teacher's stress levels circumstance (Cohen et al., 1983). The PSS, a 10-item questionnaire designed to assess the severity and frequency of perceived stressful circumstances experienced by individuals during the previous month, has been shown to be reliable in terms of internal consistency, factorial validity, and hypothesis validity ($\alpha = 0.90$).

Analysis Plan

Descriptive analysis was used to identify patterns of data using SPSS version 26.0. In addition, an independent samples t-test was used to examine gender differences in perceived stress. Next, a multiple linear regression was conducted to determine the nature of the connection between the five personality traits and the perceived stress score.

Results

According to results of descriptive and inferential analysis, below mentioned important findings were obtained. The results indicated that the majority of teachers, 46% (n = 37) were experiencing high perceived stress, and 39% (n = 31) experienced moderate stress.

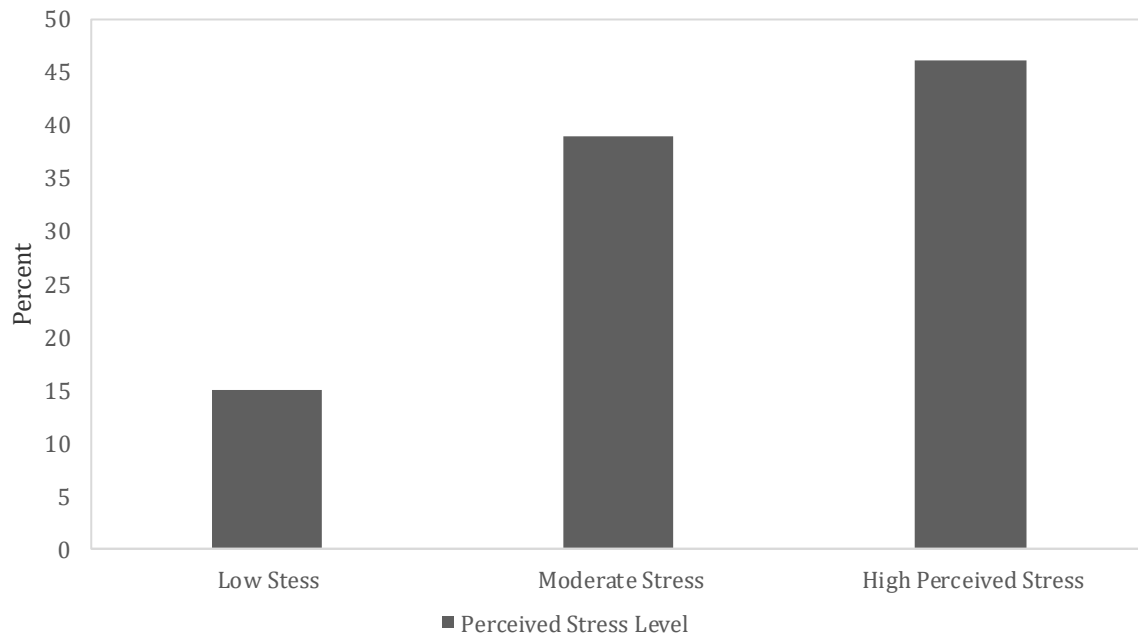


Figure 1: Frequency of the stress levels

An independent T-test was run to determine if there is a significant difference in the perceived stress scores between males and females. The results indicated that there was no significant difference in the mean perceived stress scores for males ($M = 23.7$, $SD = 6.0$) and females ($M = 25.2$, $SD = 11.0$); $t(79) = -.74$, $p = .46$ (see Table 1). Levene's test was run to test if there was homogeneity of variance, and the results showed that equal variances were not assumed.

Table 1

Independent samples t-test for Perceived Stress Score and Gender

Independent Samples Test									
		Levene		t-test for Equality of Means					
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower Upper
Perceived Stress Score	Equal variances not assumed			-.741	38.58	.463	-1.530	2.066	-5.711 2.650

A multiple regression analysis was run to assess if the personality traits measured by the BFI-10, that is neuroticism, conscientiousness, extraversion, openness, and agreeableness had an impact on perceived stress. By analyzing the results of the multiple linear regression, which was carried out, it was noted that the predictor variables (personality traits) significantly predict perceived stress level, ($F(5, 73) = 24.58$, $p < .001$). Moreover, the adjusted $R^2 = .627$

suggests that 62.7% of the variance in perceived stress level can be accounted for by the five predictors, collectively. The predicted perceived stress level is equal to $22.73 + -.137$ (conscientiousness) + $.078$ (extraversion) + $-.295$ (agreeableness) + $.508$ (neuroticism) + $-.016$ (openness), per one unit in each factor. In order to determine the impact of each trait on the outcome variable (perceived stress), coefficients were further evaluated (see Table 2).

Table 2

Multiple Linear Regression of Big Five Personality Traits on Perceived Stress Score

Personality Traits	R ²	β	t	p	95% Confidence Interval of the Difference	
					Lower Bound	Upper Bound
Conscientiousness	.243	-.137	-1.517	.134	-2.258	.306
Extraversion	.109	.078	.927	.357	-.685	1.876
Agreeableness	.395	-.295	-2.807	.006*	-3.003	-.509
Neuroticism	.495	.508	5.047	.000**	2.025	4.669
Openness	.247	-.016	-.153	.879	-1.470	1.261

*Note. Dependent Variable: Perceived Stress Sum, * $p < .01$. ** $p < .001$*

The results show that neuroticism is associated with a change in perceived stress ($\beta = .508$, $t = 5.047$, $p < .001$). This result supported the first hypothesis of this study. Contrary to the second and third hypothesis, results revealed that conscientiousness ($\beta = -.137$, $t = -1.517$, $p > .05$) and extraversion ($\beta = .078$, $t = .927$, $p > .05$) were not significant predictors of stress. It was noted that the trait agreeableness significantly, negatively predicted perceived stress ($\beta = -.295$, $t = -2.807$, $p < .01$). In addition, openness ($\beta = -.016$, $t = -.153$, $p > .05$) had no significant impact on the outcome variable, perceived stress score.

Discussion

The findings of this study revealed that the majority of the teachers were experiencing either moderate or high levels of perceived stress whilst working remotely during COVID-19 in Sri Lanka. According to the current study finding, it can be seen that the gender of the teacher did not influence their level of perceived stress. This finding is consistent with the study conducted by Solman & Fled (1989), which also found there were no significant differences in the stress perceived by male and female teachers. This is due to the fact that the sources of stressors remained greatly similar for both males and females during the COVID-19 pandemic.

From this study, it is made evident that if an individual has neurotic personality traits, they are more inclined to experience higher levels of stress. This result could be explained in light

of the findings of Schneider (2004), which suggested individuals with high neuroticism are more inclined to experience depression, irritability, and emotional instability in response to external stimuli. This suggests teachers with higher levels of trait neuroticism are more sensitive to environmental and social stressors, in comparison to teachers who score lower in trait neuroticism, which makes them more vulnerable to the effects of stress on their physical and mental health (Schneider, 2004).

Contrary to the second hypothesis of this study, the results found that individuals with high levels of conscientiousness had no impact on their appraisal of stressful situations. This finding is in contrast with existing research which proved that people with higher levels of the trait conscientiousness perceived stress less frequently (Yiwei et al., 2017).

The findings of this research indicated that individuals with a higher level of the trait agreeableness were less prone to experiencing stressful circumstances. This supported the findings of many others who reported that agreeableness was associated with stress. When considering the physiological effects of job stress, agreeableness is a protective factor, and individuals who are less agreeable are more susceptible to these effects. It is also the most predictive of experiencing low levels of stress. Teachers with greater degrees of agreeableness are less inclined to engage in interpersonal conflict, which may lead to less social stress in their line of work, which is one reason for the negative link between these factors (Bono et al., 2002).

The study included a few limitations. The sample in this study was not stratified by age or gender, which reduces generalizability of findings. However, as the majority of the participants were between the ages of 18 to 29, these results may be more generalizable to young adults. To improve the possibility that the findings would be generalizable to the rest of the population, future research should employ a stratified random sample. Secondly, external variables such as duration of work, the workload assigned to the teacher, coping mechanisms, and living conditions were not controlled in this study. These variables could have potentially influenced the results.

Conclusion and Recommendations

The findings of the current study highlight the significance of personality factors in predicting teachers' reported levels of stress. It is critical to identify the teachers who are more vulnerable to stress given the rising use of online education methods. The findings of this study show that some personality characteristics, such as greater degrees of neuroticism, increase one's susceptibility to stress. Individuals with higher levels of trait openness were less likely to experience stressful circumstances. This highlights the importance of getting to know teachers' personality types, so faculty along with psychologists might be able to better prepare interventions that benefit particular personality types. Future studies should aim to consider factors such as work experience, school environment, organisational support, and socioeconomic background as these can impact teacher stress levels. Additionally, mediation studies can incorporate factors such as burnout and self-efficacy which can be related to stress. Faculty members could change classroom practices to better accommodate different personality traits and minimize stressors for the teachers. This could minimize the stress induced the shift in teaching practices brought about by the COVID-19 pandemic.

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**THE RELATIONSHIP BETWEEN CHILDHOOD CORPORAL PUNISHMENT,
AGGRESSION, AND ANXIETY AMONG THE YOUTH IN WESTERN PROVINCE,
SRI LANKA**

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Abstract

Corporal punishment is a widely used method of discipline that has proven a relationship to several negative outcomes however a few studies have examined the repercussions of the administration of corporal punishment across Sri Lanka. The current study investigated the link between corporal punishment and aggression along with corporal punishment and anxiety in the youth of western province, Sri Lanka. Data was gathered through convenience and snowball sampling ($N = 60$; 26 males; 34 female; $M_{age} = 1.57$; $SD_{age} = .500$) which necessitated the participants to fill three questionnaires concerning corporal punishment, aggression, and anxiety. Spearman correlation revealed a significant moderate positive correlation between corporal punishment and aggression ($r_s = .536$, $p < 0.01$) along with a significant weak positive relationship between corporal punishment and anxiety ($r_s = .436$, $p < 0.01$). These findings inform that the administration of corporal punishment links to the development of aggression, and anxiety in the youth of the western province of Sri Lanka.

Key Words: corporal Punishment, externalizing behaviours, internalizing behaviours

Introduction

Corporal Punishment has been a much debated topic over the past years. Over 33 countries have legalised this disciplinary method, 63 countries have constitutionalized it as illegal, whereby 99 of the 195 countries in the world have promoted concerns and endorsed discussions regarding corporal punishment, Sri Lanka being one of them (Waterston & Janson, 2020; End corporal punishment, 2021). In the past Sri Lanka have proceeded with the stance of interdicting the use of corporal punishment in both domestic and school settings by constitutionalizing the prohibition of such actions under chapter 11 of article three in the constitution of the Democratic Socialist Republic of Sri Lanka which states that "No person shall be subjected to torture or cruel, inhumane or degrading treatment or punishment" (Commonwealth Legal Information Institute, 2000). Yet at present corporal punishment is one of the widely used methods of discipline in the present times of Sri Lankan homes and schools.

Research claims that the implementation of corporal punishment is linked and has led to several negative outcomes such as internalizing and externalizing behaviours (Rueve & Welton, 2008). Yet, large scale studies claim that three-quarter (74%) of parents from the vastly populated districts of Sri Lanka, the Colombo, Galle, Polonnaruwa, and Batticaloa districts, used corporal punishment as a disciplinary method and believed it was necessary to

implement such measures in terms of bringing correction to minors (De Silva, 2012; De Zoysa, 2008).

While corporal punishment could have lasting effects on an individual's life, continuing to both the youth and adult life of one (Ma et. al., 2012), no research has been conducted at present date in terms of the significance childhood corporal punishment has on the development of youth-based aggression, and anxiety in the western province of Sri Lanka. Therefore, it was vital to investigate if the rising reported cases of aggression and anxiety in the youth of Western province Sri Lanka (Sprigge & Wooster-Prematilaka, 2018; Rathnayake et. al, 2022; Rasalingam et. al., 2022) consist a relation to such administration as a child.

The aim of this study is to investigate if there is a relationship between childhood corporal punishment and aggression, together with childhood corporal punishment and anxiety in the youth of western province of Sri Lanka. The overall objective of this study is to measure the relationship between childhood corporal punishment and aggression, along with childhood corporal punishment and anxiety in the youth of western province of Sri Lanka.

The hypotheses for this research are as follows,

H1: There is a significant positive relationship between childhood corporal punishment and aggression in the youth of western province, Sri Lanka.

H2: There is a significant positive relationship between childhood corporal punishment and anxiety in the youth of western province, Sri Lanka

Methodology

Participants

Sixty participants (26 males; 34 female; $M_{age} = 1.57$; $SD_{age} = .500$) between the age of 18 to 28 who has received corporal punishment as a disciplinary method by one or both parents or a primary caregiver were recruited for this study from the Western province of Sri Lanka. Snowball and convenience sampling was utilized to recruit the sample through an advertisement on social media.

Materials

Dimensions of Discipline- Adult Recall Form (DDI-A)

The DDI-A is a 26 Item questionnaire of nine broader discipline method scales whereby the Discipline method scale for corporal punishment was used for this study. It consisted of four items that measured the frequency to which the discipline method, "corporal punishment" was used by both parents when the participant was aged 10. The Response category for an item such as "How often did your parents shake or grab you to get your attention?" ranged from N = Never, 0 = Not in that year, but in another year, to 9 = Two or more times a day.

Buss and Perry Aggression Questionnaire (BP-AQ)

The BP-AQ was utilized to measure the level of aggression of the participants who have received corporal punishment as a disciplinary method by one or both parents. The participants were asked to rank 29 statements like the statement "I get into fights a little more than the average person." on a 5-point continuum which ranged from 1 = extremely

uncharacteristic of me, to 5 = extremely characteristic of me, by which the total score for aggression results as the sum of the factor scores.

Becks Anxiety Inventory (BAI)

The BAI is a 21-item self-report instrument that was used to measure the severity of anxiety in the participants who have received corporal punishment from one or both parents. The participants were asked to report the extent to which individuals experienced anxiety symptoms such as "numbness or tingling" in the past month by using numerical values ranging from 0 = Not at all, to 3 = severely – it bothered me a lot.

All statistical procedures were conducted using IBM SPSS Statistics version 23; Spearman's rank correlation was utilized to investigate the relationship between corporal punishment and aggression, along with corporal punishment and anxiety in the youth of the western province of Sri Lanka.

Results

Hypotheses Testing

The findings of the Shapiro-Wilk Normality test exhibited that all variables were not normally distributed, thus including corporal punishment ($p < .001$), aggression ($p = .026$), and anxiety ($p = .031$), therefore, spearman correlation was conducted to assess the presence of a significant positive relationship between corporal punishment and aggression, along with corporal punishment and anxiety in the Youth of Western Province, Sri Lanka.

Test for outliers shows that Mahalanobis distance did not exceed the critical χ^2 for $df = 3$ (at $\alpha = .001$) of 16.27 for any case in the data file, indicating that multivariate outliers were not of concern.

Table 01: Mahalanobis distance for corporal punishment, aggression, and anxiety

	Minimum	Maximum	Mean	Std. Deviation	N
Mahal. Distance	.328	10.260	2.950	2.486	60

The corporal punishment Discipline method scale necessitated the inclusion of midpoints when recoding however no reverse coding was initiated, reverse scoring was required for two items in the Buss-Perry Aggression questionnaire (BPAQ), while the Becks Anxiety Inventory (BAI) did not require reverse scoring, therefore, normal scoring as per the provided scoring instructions proceeded.

Table 02 displays the spearman's rho correlation between corporal punishment, and aggression in the youth of Western Province Sri Lanka whereby, Spearman's rho indicated the presence of a moderate positive correlation between ranked corporal punishment and aggression levels, $r_s = .536$, $p < 0.01$, one-tailed, $N = 60$.

Table 02: *Spearman correlation between corporal punishment and aggression in the youth of Western Province Sri Lanka*

			CP_Mean	AG_Mean
Spearman's rho	CP_Mean	Correlation Coefficient	1.000	.536**
		Sig. (1-tailed)		
		N	60	60
	AG_Mean	Correlation Coefficient	.536**	1.000
		Sig. (1-tailed)	.000	.
		N	60	60

** . Correlation is significant at the 0.01 level (1-tailed).

Table 03 displays the spearman's rho correlation between corporal punishment, and anxiety in the youth of Western Province Sri Lanka whereby, Spearman's rho indicated the presence of a weak positive correlation between ranked corporal punishment and anxiety levels, $r_s = .436$, $p < 0.01$, one-tailed, $N = 60$

Table 03: *Spearman correlation between corporal punishment and anxiety in the youth of Western Province Sri Lanka*

			CP_Mean	AX_Mean
Spearman's rho	CP_Mean	Correlation Coefficient	1.000	.436**
		Sig. (1-tailed)	.	.000
		N	60	60
	AX_Mean	Correlation Coefficient	.436**	1.000
		Sig. (1-tailed)	.000	.
		N	60	60

** . Correlation is significant at the 0.01 level (1-tailed).

Exploratory Analysis

An exploratory analysis was further conducted to find gender differences in the variables, corporal punishment, aggression, and anxiety.

Gender differences in Corporal Punishment

Table 04: *Ranks of gender differences in corporal punishment*

	Gender	N	Mean Rank	Sum of Ranks
CP_Mean	Male	26	41.33	1074.50
	Female	34	22.22	755.50
	Total	60		

The Mann Whitney-U test indicated that gender differences in received corporal punishment was significant, with a small effect size ($U = 160.5$, $p < .001$, $r = -.542$). Men scored higher in corporal punishment than women.

Gender differences in Aggression

Table 05: *Ranks of gender differences in aggression*

	Gender	N	Mean Rank	Sum of Ranks
AP_Mean	Male	26	33.90	881.50
	Female	34	27.90	948.50
	Total	60		

The Mann Whitney-U test indicated that gender differences in aggression was non-significant, with a small effect size ($U = 353.5$, $p = .186$, $r = -.170$).

Gender differences in Anxiety

Table 06: *Ranks of gender differences in anxiety*

	Gender	N	Mean Rank	Sum of Ranks
AX_Mean	Male	26	37.29	969.50
	Female	34	25.31	860.50
	Total	60		

The Mann Whitney-U test indicated that gender differences in anxiety was significant, with a small effect size ($U = 265.5$, $p = .008$, $r = -.340$). Men scored higher in anxiety than women.

Discussion

The findings of the study indicate that a significant moderate positive relationship between childhood corporal punishment and aggression in the youth of the western province of Sri Lanka exists. This finding portrays that the more frequent the participants have received corporal punishment in their childhood, the higher were the levels of aggression that was elicited in their youth. The finding further aligns with the intergenerational transmission of violence theory which denotes that individuals that have been exposed to violence as a child tend to act violently, be aggressive towards their peers, and tend to utilize violence and extreme aggression as means of conflict resolution during their youth (Bandura et al., 1961; Carroll, 1980).

These results are also consistent with the claim of Bandura (1997) on intimidation and compliance which upon integration to the present findings portray that individuals who received corporal punishment in their childhood are prone to expect intimidation and

compliance using aggression and violence to meet a desired goal or for the use of personal gain. Gershoff (2002) also showed that parental corporal punishment was positively correlated with higher levels of aggression and higher levels of immediate compliance.

This second finding of the current study shows that the more intense and frequent the participants received corporal punishment as a child, higher was the anxiety elicited in their youth. The James-Lang Theory states that emotional experiences are based on physiological and peripheral sensations such as blood pressure and heart rate. When an individual comes across an event that threatens them such as intense corporal punishment, the rise of blood pressure and heart rate provokes the adaptive response of fear and anxiety (Manyande et al., 1992).

A weak positive relationship between corporal punishment and anxiety is also consistent with the previous literature. For instance, Marks (2009) found a significant positive correlation between corporal punishment and anxiety in 154 individuals from New Orleans. Similarly, a study involving 170 college students from Irish and Italian ethnic background by Bryan and Freed (1982) disclosed that individuals who reported receiving excessive amounts of corporal punishment in their childhood displayed low self-concept and anxiety. This further justifies the relationship and effect corporal punishment has on the development of anxiety in the youth whilst also displaying that such result does not vary across cultures.

Conclusion and Future Recommendations

To assure validity, the use of a higher sample size would be recommended, with which the findings will be more generalized. Future research could investigate why corporal punishment was administered along with the parent's mental wellbeing at the time of administration. A parent who had prolonged aggressive behaviours or has not sought professional help for present aggression may be much more triggered by ignorable acts of a child thus leading to the unfair administration of corporal punishment. The number of members in the family of the participant could also be taken into consideration as parents of families with more children with short age gaps are more prone to administer corporal punishment to their children in general (Miller-Perrin & Perrin, 2018). Despite the limitations of the current study, the findings of this study show that a positive relationship between childhood corporal punishment and aggression along with a positive relationship between childhood corporal punishment and anxiety is present. The findings of this study may contribute to the settings of counseling, advocating, and spreading awareness.

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THE EFFECTS OF INSTAGRAM USAGE ON SELF-ESTEEM

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Abstract

The current study aimed to examine the effects of Instagram use on an individual's self-esteem and social comparison tendencies. Additionally, the study examined if different usage patterns affect self-esteem and social comparison differently. Participants between the ages of 18 to 35 years (9 males; 57 females; 1 unmentioned) were invited to complete an online questionnaire. The results indicated no significant relationship between Instagram usage and self-esteem ($r(67) = -.012, p = .92$) or Instagram usage and social comparison ($r(67) = (.228), p = .06$). However, a relationship was observed between active use and social comparison ($r(67) = .333, p = .006$), passive use and social comparison ($r(67) = .247, p = .04$), and between social comparison and self-esteem in participants between 18 to 24 years ($r(50) = -.307, p = .03$). These findings indicate that frequent usage of Instagram can affect one's self-esteem, as social comparison, which impacts self-esteem, increased in both active and passive users.

Keywords: Instagram, Self-esteem, Social comparison

Introduction

Social media has evolved into an essential part of daily life. The development of platforms such as Facebook and its predecessors have made new ways for people interact and communicate, form relationships, and receive and share information (Trifiro, 2018; Jiang & Nigel, 2020). With the shift it has brought to the world, it is important to identify if and how social media affect its users. Previous research have identified that continuous use of social media can predict peer competition and affect symptoms of eating disorders, body dissatisfaction, and life satisfaction in adolescent girls (Ferguson et al., 2014). Certain studies have shown that high social comparison orientation is positively associated with Facebook use and causes poorer self-perception Vogel et al. (2015).

Instagram introduced a different approach to communication, which moved from text-based to an image-based form of sharing and receiving content (Jiang & Nigel, 2020). Being a relatively new platform, the research on its implications is limited, and therefore, more studies are essential to deepen the understanding of its influences. Sharing photographs for self-presentation, Instagram creates an ideal platform to visually interact with others, and even compare oneself to others. The current study focuses on the effects of Instagram usage on self-esteem and social comparison. Self-esteem is formed and maintained through self-evaluation, and it is essential to one's well-being, mentally, socially, and emotionally (Mann et al., 2004; Ziger-Hill, 2013; Du et al., 2017). Self-esteem is heavily influenced by the process of social comparison (Stangor et al., 2014). When social comparison occurs favorably self-esteem increases, whereas if it occurs negatively self-esteem decreases (Stangor et al., 2014).

Self-esteem and social comparison significantly influence one's well-being. Therefore, this study aimed to identify the relationships between the variables of the level of Instagram usage, self-esteem, and social comparison, and, active or passive usage patterns, and self-esteem and social comparison. It also aimed to fill certain research gaps found in previous literature such as focusing on the 18 to 24 and 25 to 35 age groups, objectively measuring Instagram usage levels and identifying its relationships with self-esteem and social comparison, and how self-esteem and social comparison are impacted by active and passive usage of Instagram. To investigate these aims, the study was driven by two hypotheses:

H1: Higher levels of Instagram usage will negatively affect self-esteem levels.

H2: Higher levels of Instagram usage will increase social comparison levels.

Methods

Participants

This study used convenience sampling. A text message invite was shared via WhatsApp and Instagram, to gather participants for the study. Participants needed to be of Sri Lankan nationality, between the ages of 18 to 35 years with an Instagram account. This study aimed to gather over 40 participants, as this is the minimum number of participants required in most quantitative studies, to result in a reasonable prediction (Budi & Moran, 2021). This study was able to gather 67 participants in total. 13.4% (N=9) of the participants were males, 85.1% (N=57) females and 1.5% (N=1) did not mention their gender. 74.6% (N=50) of participants were between the ages of 18 to 24 years, while 25.3% (N=17) of participants were between the ages of 25 to 35 years.

Design and Ethics

This study used a correlational design. The variables that were measured were Instagram usage, level of self-esteem, level of social comparison, age group, and Instagram usage pattern. These variables were measured through an online questionnaire, created using the Qualtrics software.

Ethical approval for the current study was given by the Ethics Committee of Cardiff School of Sports and Health Science. The ethical guidelines of the British Psychological Society (2021) were followed. Informed consent was obtained prior to answering the questionnaire and it was made clear that the participants had the right to withdraw at any point of the questionnaire. No deception was used in the study, the participants were informed about the aims of the study at the start of the questionnaire and were debriefed before submitting their data. As this study examines self-esteem, it may be a sensitive area for some participants. Hence, the contact information of necessary resources was provided for each participant in the information sheet.

Materials

The following scales were used to measure the variables of the study; Rosenberg Self-Esteem Scale (Cronbach's $\alpha=.833$) (Rosenberg, 1965), Instagram Intensity Scale (Cronbach's $\alpha=.725$) (Trifiro, 2018), Passive and Active Use Measure (Cronbach's $\alpha=.757$) (Trifiro, 2018), and Iowa-Netherlands Comparison Orientation Measure (INCOM) (Cronbach's $\alpha=.706$) (Gibbson & Buunk, 1999).

Procedure

The participants were directed to the online questionnaire, they read the participant information sheet and gave of informed consent. The participants answered demographic questions and answered the following questionnaires in the order; Rosenberg Self-Esteem Scale, Instagram Intensity Scale, Passive and Active Use Measure, and INCOM. The participants were thanked for their participation. The time taken to complete a questionnaire was about 10 to 15 minutes. IBM SPSS version 26 was used to conduct the statistical requirements of the study.

Results

A Spearman's Rho correlation was conducted to investigate correlations between the variables. This was done instead of a Pearson correlation, as the test of normality showed the data was skewed (Table 1). The data that were analyzed are ordinal data obtained through different Likert scales. Correlations between, Instagram intensity and self-esteem, Instagram intensity and social comparison, active use and self-esteem, active use and social comparison, passive use and self-esteem, and passive use and social comparison, were measured.

Table 1

Test of Normality; Shapiro-Wilk

Scales	Statistic	df	Sig
Rosenberg's Self-Esteem Scale	.984	67	.549
Instagram Intensity Scale	.962	67	.039
INCOM	.986	67	

The effect of Instagram usage on self-esteem

To identify whether higher levels of Instagram usage will negatively affect self-esteem, Spearman's Rho correlations were conducted. The means of the scale items in the Instagram intensity scale ($M= 3.23$, $SD= .65$) and Rosenberg's self-esteem scale ($M= 2.74$, $SD= .45$), were calculated for data analysis. The summarized results are displayed in Table 3.

The effects of Instagram usage on social comparison

Spearman's Rho correlations were conducted to identify whether higher levels of Instagram usage will increase social comparison tendencies. The mean of the INCOM scale was calculated for data analysis ($M=3.15$, $SD= .49$). The summarized results are displayed in Table 2.

Table 2

Descriptive Statistics and Correlations for Study Variables

Variable	M	SD	1	2	3	4
1. Self-Esteem	3.23	.65				
2. Instagram Usage	2.74	.45	-.012			
3. Social Comparison	3.23	.65	-.301*	.228		
4. Passive Use	3.44	.71	-.145	.541**	.247*	
5. Active Use	2.59	.7	-.068	.586**	.333**	.471**

** $p<0.01$ (2-tailed); * $p<0.05$ (2-tailed); $n=67$

Table 3

Descriptive Statistics and Correlation for Study Variables in Ages 18 to 24 years

Variables	M	SD	1	2
1. Self-Esteem	2.72	.427		
2. Instagram Usage	3.22	.596	-.044	
3. Social Comparison	3.18	.459	-.307*	.136

** $p < 0.01$ (2-tailed); * $p < 0.05$ (2-tailed); $n = 50$

Table 4

Descriptive Statistics and Correlation for Study Variables in Ages 25 to 35 years

Variables	M	SD	1	2
1. Self-esteem	2.79	0.508		
2. Instagram Intensity	3.26	0.823	0.007	
3. Social Comparison	3.06	0.577	-0.168	0.418

** $p < 0.01$ (2-tailed); * $p < 0.05$ (2-tailed); $n = 17$

Discussion

The results of the current study consisted of mainly those of statistical insignificance. However, weak positive correlations were observed between active usage and social comparison, and passive usage and social comparison. Furthermore, a negative correlation was also found between social comparison and self-esteem, in the 18 to 24 years age group. Instagram being a visually driven platform, one's body image or appearance self-esteem may be more clearly impacted by the platform (Pedalino & Camerini, 2022). Gallinari (2017) and Steinsbekk et al. (2021), were two such studies that used scales to measure appearance self-esteem. Gallinari (2017) was able to identify that social media praise led to increased appearance self-esteem, and Steinsbekk et al. (2021), found that other-oriented Instagram usage led to negative appearance self-esteem. Nevertheless, previous studies have also been able to identify a negative relationship between high Instagram use and global self-esteem (Vogel et al., 2014; Trifiro, 2018).

In the current study, a positive correlation was observed between both, active usage and social comparison, and passive usage and social comparison. This indicates that whether the participants were actively or passively engaging on the Instagram platform, their social comparison tendency would increase. An interesting takeaway from this is the idea that Instagram usage does affect an increase in social comparison. Furthermore, an unexpected negative relationship was found between social comparison and self-esteem, when analyzing these variables of participants aged 18 to 24 years. Social comparison is known to contribute to low self-esteem (Stangor et al., 2014; Jiang & Ngien, 2020), and this claim is also supported by the findings of the current study. In addition to this, the positive correlations between the usage patterns and social comparison, may also suggest an impact on self-esteem due to Instagram use.

The two hypotheses cannot be accepted as no meaningful relationships were found, however, due to findings of previous research, it is not possible to completely dismiss relationships between the studied variables. It is important to investigate what factors led to these

relationships not being significant. Along with such factors, the current study also consisted of a few limitations.

Firstly, the current study aimed to examine how high Instagram usage affected the self-esteem levels of Sri Lankans from ages 18 to 35 years. However, due to the sampling methods used, most of the participants were from only one area of Sri Lanka and can be assumed to have shared similar social standings. This makes the sample not representative of the entire target population. This, therefore, limits the generalizability of the obtained findings.

Conclusions and Future Recommendations

Despite these limitations, the present study added to the under-researched field of Instagram. The current study brought attention to the age group of 25 to 35 years, which has not been given adequate attention throughout previous research. The study also examined the effects of Instagram usage on self-esteem in Sri Lankans, which is a demographic not sufficiently researched before on this topic.

For future research in this area, it would be useful to further expand and explore the current findings. To better examine different usage patterns, more effective methods need to be identified and used. Conducting research incorporating both quantitative and qualitative methods may result in more beneficial findings.

The present study contributes to a growing body of research that indicates that the high usage of Instagram impacts one's self-esteem. Instagram usage increased social comparison, which is a factor that plays a role in influencing self-esteem. As seen in previous findings and the present study, Instagram has the potential to negatively impact one's well-being in emotional, social, and psychological aspects. Therefore, these findings further exemplify the need to better understand Instagram's influences on its users.

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**IMPACT OF HUMAN RESOURCE PRACTICES ON TEACHERS' TURNOVER
INTENTION: THE MEDIATING ROLE OF ORGANIZATIONAL JUSTICE IN
PRIVATE SCHOOLS IN SRI LANKA**

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Abstract

The high labor turnover in private international schools is a key matter that had been debated over time. When the teachers are frequently leaving their workplace, it will have huge impact on students' education and their future. Thus, this high turnover among the teachers in international schools is a social issue and need attention of researchers in Sri Lanka.

This research is aimed to evaluate the Impact of HR practices on employee turnover intention with organizational justice function as the mediating variable on the relationship between HR practices and turnover intention. The research is conducted in ABC private school in Colombo. It was found out that HR practices negatively and significantly influence the turnover intention of the teachers in international schools. Further it was found out that organizational justice function as significant factor that transmit the impact of HR practices on turnover intention in addition to the direct impact of HR practices on turnover intention.

Key Words: Human resource practices, Organizational justice, Private schools, Turnover intention, Teachers

Introduction

With the opened economy, the private sector also entered into education in Sri Lanka with opening of private / international schools. The quality of the education provided by these international schools is not regulated by any independent regulator. Therefore, the private international education level and quality is changed according to the business objectives of the organization that runs the international school.

Last 5 years, the turnover of major 10 private schools are indicated in Table 1.

Table 1: Teacher turnover of major 10 private schools 2017 - 2021

	2021	2020	2019	2018	2017
Turnover	43%	42%	40%	39%	34%

Source: Authors findings.

It had been a discussion at most of international schools about the high labour turnover of teachers causing damage to the students. There can be many reasons for Turnover, and it is important to understand reasons for teachers at international schools to leave their workplace which would be helpful to reduce the high turnover of teachers.

Therefore, this research is intended to fill this empirical gap answering the research problem; what is the impact of human resources practices on turnover intention with mediating effect of organizational justice on the relationship between private school teachers in Sri Lanka?

There is research done related to labor turnover in global context, but in Sri Lankan context still there are lack of research related to the private education. This study address how human resource activities and organizational justices influence turnover intention of private school teachers in Sri Lanka while organizational justice acts as a mediator.

Research Objectives

This research will be conducted to achieve the following objectives.

- I. To examine the impact of HR practices on the turnover intention of the private school teachers in Sri Lanka
- II. To investigate the impact of HR practices on the organizational justices of the private schoolteachers in Sri Lanka.
- III. To evaluate the impact of organizational justices on the on the turnover intention of the private school teachers in Sri Lanka.
- IV. To investigate the mediating effect of organizational justices on the relationship between HR practices and employee turnover of the private schoolteachers in Sri Lanka.

Significance of the Study

This study provides comprehensive knowledge related the employee turnover and this provide practical and theoretical significance. There is less research that have done in employee retention problems and human resource activities in the Sri Lanka. Hence the findings can be used to formulate the strategies for increase the retention rate in the private schools and improve the company performance of the teachers. Even though this study emphasized on private school, the findings can be used in general for all industries to initiate the strategies and polices in order to reduce their labour turnover by formulating effective HRA practices.

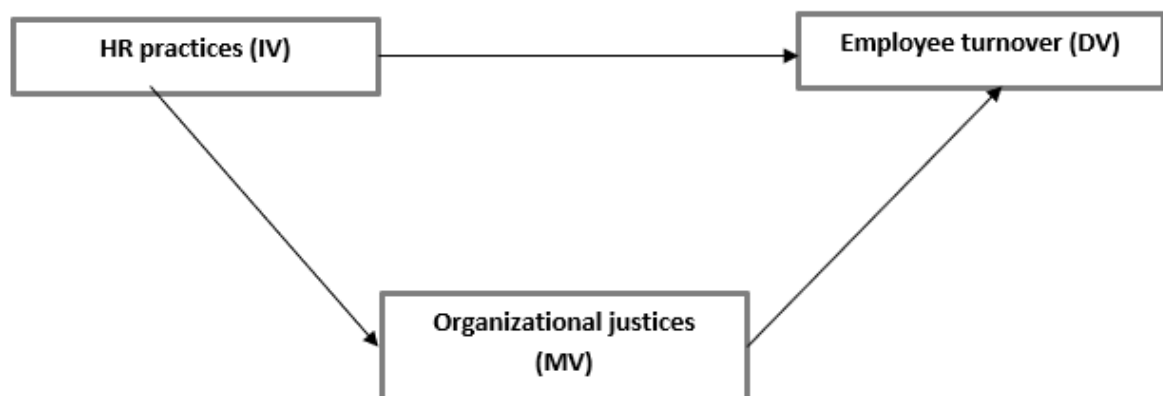


Figure 1: Conceptual Framework

Methodology

Sampling design

The target population of the study was 115 upper schoolteachers in ABC private school. Morgan table was used for the selection of the sample. Accordingly, sample size is 89 upper schoolteachers in ABC private school. Simple random sampling technique was used to distribute questionnaires among 89 upper schoolteachers.

Analysis techniques

Dataset is formed in Package for Social Sciences (SPSS) work sheet that consists of both categorical and continuous variables. As well as the statistical analysis will be done using Package for Social Sciences (SPSS version 21.0). In all statistical tests $p < 0.05$ was defined as being significant. Linear regression is employed to evaluate the causal relationship between variables and to quantify the causal relationship (Hair, J. F., Ringle, C. M., & Sarstedt, M, 2011). It has been identified that, organization justice acts as a mediator between employee turnover and HR practices. With the help of Sobel test, the significance of the indirect effect can be evaluated.

Results & Discussion

It is recorded a 100% response rate for the questionnaire. Sample was dominated by Females (78%) with a majority having bachelor's degrees 65.2%. Out of total 89 sample members, 31.5% were in the age range 31-40, whereas 28.1% were between 20 to 30 ages in the sample. More than half of the respondents were married 52.8%, and a majority of 68.9% have worked at ABC school for less than 5 years only.

Table 2: Demographic analysis

Variable	Percentage	Variable	Percentage
Gender		Education qualifications	
Male	78%	Bachelor's Degree	65.2%
Female	22%	Master's degree	33.7%
		Above	1.1%
Age		Total work experience	
20yrs - 30yrs	28.1%	Less than a year	7.9%
31yrs - 40yrs	31.5%	1-5years	25.8%
41yrs – 50yrs	28.1%	5-10years	33.7%
51 and above	12.4%	More than 10years	32.6%
Marital Status		Experience with ABC	
Single	47%	Less than a year	23.6%
Married	53%	1-5years	39.3%
		5-10years	25.8%
		More than 10years	11.2%
Current monthly salary			
Less than 50,000 LKR	23.6%		
Between 50,000-70,000	42.7%		
Between 70,000-90,000	22.5%		
More than 90,000	11.2%		

Table 3: Correlation Coefficients

		HRP	TI	OJ
HRP	Pearson Correlation Sig. (2-tailed) N	1		
TI	Pearson Correlation Sig. (2-tailed) N	-.901 .000 89	1	
OJ	Pearson Correlation Sig. (2-tailed) N	.863 .000 89	-.894 .000 89	1

The correlation coefficient between HRP and TI, HRP & OJ are negative implying that variable sets are going opposite direction. This can be argued as when Human resources practices and organizational justice improves, turnover intention of employees are getting reduced. The correlation coefficient between HRP and OJ is positive implying that when the HRP is improved, organization justice will also get improved.

Using Multiple Linear Regression

$$ETI = \beta_0 + \beta_1 (HRP) + \beta_2 (OJ) + \varepsilon \dots\dots\dots (1)$$

Whereas,

ETI = Employee turnover intention (Dependent variable)

HRP = HR practices (Independent variable)

OJ = Organizational justices (Mediating variable)

ε = error term

Table 4: Summary of Multiple linear regression

Source	B	SE B	β	t	p
(Constant)	0.517	0.074		6.949	0
HRP	-0.273	0.051	-0.309	-5.399	0
OJ	-0.577	0.054	-0.616	-10.775	0

Table notes

- unstandardized beta (B)
- standard error for the unstandardized beta (SE B)
- standardized beta (β)
- t test statistic (t)
- probability value (p)

Unstandardized B of HR practices and organizational justices are -.273 and -.577 ($p < .05$). Therefore, both coefficients are statistically significant.

$$ETI = \beta_0 + \beta_1 (HRP) + \beta_2 (OJ) \dots\dots\dots (2)$$

$$MOT = .517 - .273 (HRP) - .577 (OJ) \dots\dots\dots (3)$$

The interpretation of coefficients can be explained as follows:

A one-unit change in human resource practices would change the employee turnover intention by 0.273 units, and a one-unit change in organizational justices would change the employee turnover intention by 0.577 units. Both effects are significant and negative.

The value of HR Practices is not zero in multiple linear regression model; hence mediation exists, and it is a partial mediation.

Sobel test is performed to assess the significance of the mediating effect

Table 5: Sobel Test result

Input:		Test statistic:	Std. Error:	p-value:
a	.850	Sobel test: -10.22975425	0.04794348	0
b	-.577	Aroian test: -10.22601875	0.04796099	0
s _a	.024	Goodman test: -10.23349384	0.04792596	0
s _b	.054	Reset all	Calculate	

There was a significant indirect effect of the human resources practices (IV) via the organizational justices (mediator), Sobel's $z = -10.23$, $p = .000$.

The research model was developed with the help of studies conducted in other countries, and it assumes that HR practices are a key factor that influences turnover intention, and organizational justice also mediates the impact of HR practices on turnover intention by transmitting a portion of the influence of HR practices to the turnover intention through organizational justice, in addition to the direct impact of HR practices on turnover intention. The key tool utilized to investigate the causal links between HR practices and turnover intention, HR practices and organizational justice, and organizational justice and turnover intention was regression analysis.

This study considered only four dimensions of HR practices. There are many dimensions that had been evaluated by researchers in the HR filed. Those dimensions also should be incorporated in future research. The research was conducted only at ABC School. To get better understanding the research should be done with a larger population covering most of the private school teachers.

Conclusion & Recommendations

Negative relationship in the established regression model signifies that when the HR practices are improved at the organization, the turnover intention of its employees are reduced and when the HR practices are getting worse, the turnover intention of its employees are increased. Good HR practices would improve the key dimensions considered in this study: Compensation and Reward Management, Training & Development, Career Opportunity, Performance Appraisals are improved, these improvements will have positive impact on the employees to reduce their turnover intention and vice versa.

The HR practices has significant and positive impact on the organizational justice. When the organization employed good HR practices, it will improve the organization justice in the same direction. It was found out that there is a partial mediation effect provided by the organizational justice. Hence Organizational justice would function as the mediator on the relationship between HR practices and Turnover intention of teachers at ABC School.

Thus, it is recommended to engage good HR practices through application of good compensation and reward management programs, enhancing the training and development of the teachers, allowing career opportunities for the teacher and employ professional performance appraisal system. It is important to follow professionally developed, key performance indicator-based performance appraisal system which can be linked to the compensation and rewards system of the school. Further KPI should be established to encourage teachers to enhance their knowledge by obtaining higher academic qualifications such as post graduate diplomas, MBAs, MPhils, and PhDs.

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