JOURNAL OF MULTIDISCIPLINARY RESEARCH

VOLUME 4 ISSUE 1, JANUARY – JUNE, 2024

FACULTY OF POSTGRADUATE STUDIES

& PROFESSIONAL ADVANCEMENT

NSBM GREEN UNIVERSITY, SRI LANKA

NSBM GREEN UNIVERSITY TOWN

AACSB Business Education Alliance Member

UNIVERSITY OF PLYMOUTH

VICTORIA UNIVERSITY MELBOURNE AUSTRALIA

Affiliated exclusively to top-ranked universities

JOURNAL OF MULTIDISCIPLINARY RESEARCH

VOLUME 4 | ISSUE 1 | JANUARY – JUNE, 2024

ISSN: ISSN 2815-0023

FACULTY OF POSTGRADUATE STUDIES & PROFESSIONAL ADVANCEMENT

NSBM GREEN UNIVERSITY

PITIPANA, HOMAGAMA, SRI LANKA

PHONE: 0115 445 000 | +94 71 244 5000

WEB: https://www.nsbm.ac.lk

JOURNAL OF MULTIDISCIPLINARY RESEARCH

VOLUME 4 ISSUE 1, JANUARY – JUNE, 2024

JOURNAL POLICIES AND STANDARDS

The Journal of Multidisciplinary Research (JMR, ISSN 2815-0023) is published annually by the Faculty of Postgraduate Studies & Professional Advancement, NSBM Green University, Sri Lanka. The journal that focuses on critical and creative research which provides an international forum to disseminate knowledge. It expects to be the voice of scholars and practitioners in multiple disciplines around the world. JMR seeks original and innovative research, as well as novel analysis to cultivate fruitful dialogues between previous and innovative thoughts. The journal promotes original academic research in management, computer science, engineering, social science, clinical research, education, science & technology.

Editorial Policies

Manuscripts of papers, articles, reviews, concepts, etc., are accepted for publication on the understanding that they have not been published or submitted simultaneously for publication elsewhere. All parties are being introduced with their rights and responsibilities to ensure a smooth and ethical publishing process.

Authorship

Anyone identified as an author must have made a substantial intellectual contribution to the research and the writing of the article. Authors must be willing to take a shared responsibility in the research and the article and approve the final version to be published. All authors are responsible for ensuring that;

- The manuscript is their original work and does not duplicate previous work
- The manuscript has been submitted only to this journal
- The manuscript contains nothing abusive, defamatory, libelous, obscene, etc.

Non-compliance with any of the above conditions will be considered misconduct and dealt with accordingly. Equally, if authors are found guilty of infringing any of the above, the publisher reserves the right to charge the authors with costs which the journal infringing for their manuscript at the discretion of the Journal's Editors and the publisher. During the review process, the editorial board or reviewers may seek data,

which the authors must be willing to provide. The publisher or editorial board of NSBM Green University will not be held liable for the consequences of any such inaccuracies. Further, no part of this journal may be produced without the expressed permission of the copyright holder, the NSBM Green University.

Refereeing and Editing

All papers submitted for publication are examined and evaluated by referees through a blind review process, to determine their suitability for publication. The editor reserves the right to edit the materials to conform to the style and format of the journal. Each submission is reviewed for suitability and may be rejected; if it is of insufficient quality, or is missing important sections. When the decision of minor/major revision is made, and the authors do not revise their articles satisfactorily after receiving reviewer reports, then the editor reserves the right to reject the article. When revised articles are received they will either be sent out for further review or the editor will make a decision depending on the level of revision requested.

Plagiarism Policy

Any data, images, phrases, words, or ideas taken from any materials in electronic or print formats without sufficient attribution are considered violation of the JMR plagiarism policy. The use of any such material either directly or indirectly should be properly acknowledged or cited in all instances.

Correspondence

All correspondence regarding journal papers should be sent to Narmada Balasooriya, the editorial assistant (narmada.b@nsbm.ac.lk), to the JMR. Sales requests should he addressed to the Librarian, NSBM Green University (library@nsbm.ac.lk).

EDITORIAL

The Journal of Multidisciplinary Research (JMR) is an attempt to promote research excellence through collaborations and incorporation of multi discipline. In this issue of the forth volume ten articles have been selected for publication related to management, computing, science, and engineering.

The first article, investigate the impact of customer purchase intention on fast-moving consumer goods in supermarkets in the capital of Sri Lanka. The second article authored by a group of researchers from engineering background discuss a machine learning approach to improve the reliability of powertrain systems in Autonomous Guided Vehicles (AGVs). The third article discusses the impact of impact of public investment on economic growth in Sri Lanka. The next article is a case study conducted targeting the undergraduates in a private university in Sri Lanka. The study focuses on a quantitative approach and looks into the views of tax evasion among undergraduate students. The following article discusses a timely topic "Perfumes and Health" unveiling the related chemical hazards and environmental concerns. The next article has elucidated the significant influence of e-procurement practices on organizational performance within the context of Sri Lankan supermarkets. Another case study based on Sri Lankan undergraduates, and investigates their intention of engaging in socially responsible investments. The next article, a cross-sectional study aims to achieve zero deaths due to dehydration in children while the next article is a comprehensive analysis and implementation of a predictive inventory management system for optimizing blood supply chain management. The last article discusses a consumer behavior focusing on the gen Z consumers.

Dr. Rasika Ranaweera (Editor-in-Chief)

Journal of Multidisciplinary Research (ISSN 2815-0023)

THE IMPACT OF GREEN PACKAGING OF FAST-MOVING CONSUMER GOODS ON CUSTOMER PURCHASE INTENTION - A SPECIAL REFERENCE TO SUPERMARKETS IN COLOMBO DISTRICT

DISANAYAKA O R, DE SILVA L

Faculty of Postgraduate Studies & Professional Advancement,

NSBM Green University, Sri Lanka

ovidisanayaka26@gmail.com, lasitha.d@nsbm.ac.lk

Abstract

The main purpose of this research study is to investigate the impact of customer purchase intention on fast-moving consumer goods in supermarkets the in Colombo district. To achieve the main purpose of this study has three research questions.

RQ1. What is the relationship between green packaging and customer purchase intention?

RQ2. How is the customer's awareness of green packaging?

RQ3. How do demographic factors of consumers affect the purchase intention of green-packed FMCG?

This study only investigated the consumers who use green-packaged fast-moving consumer goods in supermarkets in the Colombo district. The research model is created to investigate the relationship between three key independent factors (willing to pay, environment concern and customer attitudes) and customer purchase intention (dependent variable). The main aim of this study identifies the relationship between green packaging and customer purchase intention. 322 responses from fast-moving consumer goods consumers who utilize green packaging served as the basis for statistical analysis. The reliability of the scale was tested using standard statistical techniques. The hypothesis was tested using regression analysis. Physically distributed questionnaires were used to capture primary data and secondary data were collected through articles, books. Data obtained were analyzed using SPSS version 26 (Statistical Analysis Tool) and Microsoft Excel.

Keywords: Green Packaging, Customer Purchase Intention, Customer Attitudes, Environment Concern, Fast Moving Consumer Goods

1. Introduction

Environmental pollution is a main pressing problem because of globalization and industrialization. Due to the increase of environmental pollution, in the past two decades, the world community has given a lot of attention to the environment similar to many other Asian nations, Sri Lanka is experiencing rising levels of air hazardous waste, exposure to noisy traffic, high levels of waste disposal and rapidly decreasing landfill space in most urban areas (Samarasinghe & Ahsan, 2014). As environmental risks become a concern for local governments and residents across Asia, the power of "going green" is already spreading there. Environmental contamination is a very complicated issue nowadays and many environmentally concerned people are becoming more and more aware of this (Whiegar, 2012).

Eco-unfriendly packages can pollute the environment in various ways. The biggest problem with them is the use of environmentally unfriendly packaging materials (Vidya, 2019). Packages that are not environmentally friendly are very long-lasting environmental pollutants. Unfriendly business practices have led to increasing environmental concerns. Therefore, many organizations are implementing environmentally friendly concepts as green supply chain practices. Green supply chain techniques are still a recent phenomenon in Sri Lanka. Companies are making a sincere effort to green their supply chains by implementing green concepts throughout their organizations and supply chains. Green packaging is a key component of green supply chain practices.

Green packaging is often referred to as eco packaging, eco-friendly packaging and sustainable packaging. Eco-friendly packages are the best alternative to wasteful packaging materials like plastic. Green packages are made from recyclable and biodegradable substances. Their manufacturing techniques are used to reduce energy. Green packages minimize the negative environmental impacts. Mushroom packaging, organic fabric, recycled cardboard and cornstarch packaging are examples of green packaging. Australia produced 50 million tons of waste in 2016, of which only 58% was recycled. Packaging pollutes the environment and adversely affects it in various ways, including the production of solid, liquid and gaseous pollutants (Kashif & Rani, 2021). Packaging supports businesses' marketing initiatives(Susanti et al., 2017). The

packaging type could boost an organization's brand recognition and attract a new customer base. Green packaging and consumer purchase intention are influenced by several key factors. Such as a person's perspective on eco-friendly packaging and their familiarity with it (Kashif & Rani, 2021).

Regarding their purchasing intention, retailers take into account consumers' views and inclinations to pay for a specific buying activity (Kashif & Rani, 2021).Green purchase intention refers to the consumer's ability and inclination to choose an environmentally friendly product over conventional products when the consumer is concerned about the environment and is aware of these concerns. The global "green concept" including green economies and sustainability is becoming increasingly popular and many nations are beginning to embrace it. As a result of the consumer's acquisition of green information, their view of the world changes, which affects their behavior and ultimately their purchasing intentions (Kashif & Rani, 2021). Today's consumer purchase intention is tied to eco-friendly concepts. Over time, both the need for environmentally friendly products and consumer loyalty have intensified (Whiegar, 2012).

2. Literature Review

2.1 Theory of Planned Behavior

Ajzen developed the Theory of Planned Behavior (TPB) in 1985 by adding a new predictor to reasoned action (TRA) that was consistent with the predictors in the theory (Saut & Saing, 2021). A more comprehensive model that allows social psychologists to predict behavioral intention is the Theory of Planned Behavior (TPB), an extension of the Theory of Reasoned Action (Ahmed et al., 2021). The theory of planned behavior gives us a perfect framework to investigate the factors that influence people's decisions to engage in environmentally responsible behaviors such as recycling and it can also be used to systematically understand the various factors that influence people's purchasing behavior for environmentally friendly goods (B. Kumar, 2012). The theory proposed that behavioral intentions influence individual behavior are primarily triggered by attitudes and subjective norms and focus on predicting human behavior (such as purchasing or decision-making) based on circumstances or subjective context (Ahmed et al., 2021).

The theory of planned behavior (TPB) advances the theory of reasoned action by addressing the original model's shortcomings of dealing with insufficient voluntary control (B. Kumar, 2012). According to the TPB, the likelihood that someone will copy a behavior increases in direct proportion to how positively they feel about it (Amoako & Dzogbenuku, 2019).The TPB has also been widely applied to understanding ethical behavior. Purchasing green or environmentally friendly products are also an ethical choice (B. Kumar, 2012). Shukla (2019) explained as, according to the theory of planned behavior, attitude is the main factor that determines whether a consumer will make a purchase and is therefore defined as "an individual's mental tendency to judge the behavior in question favorably or unfavorably. In various fields, the TPB has been used to predict intention and behavior (Amoako & Dzogbenuku, 2019).The TPB has been used in prior studies and extended in several ways to examine consumers' purchase intentions for green items (Zhang et al., 2019). According to the TPB, if a person has a favorable attitude toward a behavior, is accepted by others for engaging in it, and has more control over it, he is more likely to engage in a behavior (Sreen et al., 2018).

The TPB has been used effectively as an explanatory aid and is frequently used to predict intentions and behavior(Photcharoen et al., 2020).For example, TPB has been used to study topics including green products, energy efficient items, and green hotels and restaurants. The findings of this research demonstrated the relevance and robustness of the TPB and provided strong empirical support for the theory's use in anticipating pro-environmental behavior(Amoako & Dzogbenuku, 2019).In addition to attitude and subjective norms, TPB adds perceived behavioral control to predict purchase intention (Sreen et al., 2018).

2.2 Green Supply Chain Management

Green supply chain management (GSCM) is one of the most important organizational concepts for mitigating environmental risks (Sugathadasa et al., 2021). Scholars and practitioners are proposing the idea of GSCM as a potential means of enhancing environmental performance (Tseng et al., 2019). A "green supply chain" or "sustainable supply chain" refers to a supply chain that incorporates environmentally sound procedures along with standard, timely procedures (S & Singh, 2019). GSCM was first proposed in the early 1990s, however it is currently growing in popularity as evidenced

by the growth of scholarly publications in the 2000s (Tseng et al., 2019). Faced with emerging environmental challenges and intense business competition, Sri Lankan supermarket chains have recognized the importance of implementing the "green" concept in their business (Sugathadasa et al., 2021). These environmental processes can include any number of activities, from choosing environmentally friendly suppliers to purchasing environmentally friendly materials, from developing environmentally friendly products to manufacturing them, from sustainable distribution to managing them until the end of their useful life(S & Singh, 2019). Similar practices are followed by GSCM, but in a more creative, cost-effective, widely recognized and socially and environmentally responsible manner(Ali et al., 2017). Green supply chain management is the use of business procedures from the acquisition of raw materials through the delivery of products or services and after-sales delivery in an environmentally friendly and green manner (T. T. H. Nguyen et al., 2020). Traditional supply chain management (SCM) has expanded to include green supply chain management (GSCM) which takes environmental concerns into account (Ali et al., 2017).

2.3 Green Supply Chain Practices

Everyone is now focused on creating a sustainable and eco-friendly environment. Global warming and environmental degradation have increased because of the environmental impact of technological advancement in the modern world. As a result, people today are more aware of the environment. Given the growing severity of environmental problems caused by human activities such as the greenhouse effect, water scarcity, air pollution, noise pollution and species extinction, it is very important to reduce the adverse effects of human activities on the environment (Becker et al., 2015). Due to those reasons, the world is moving towards greening. The adoption of environmental sustainability and the prioritization of green supply chain practices, according to various research, can help supply chains and businesses become more environmentally friendly (Chiu & Hsieh, 2016). In the supply chain context, "green practices" is a contemporary concept that protects the sustainability of the environment (Khan & Qianli, 2017).

Protecting the environment, mostly by reducing pollution caused by carbon footprints, is one of the main goals that businesses pursue in going green (Qin et al., 2021). Green

supply chain management practices are part of organizations that examine the environmental management efficiency of goods bought and sold, as well as the cost of waste disposal and the calculation of emissions from enterprises(T. T. H. Nguyen et al., 2020). The term "green supply chain practices" (GSCP) is often used to refer to the various actions taken by an organization to reduce its negative impact on the environment. Supply chains work to maintain their internal sustainability and environment by having the ability to self-correct based on information from the external environment(Diab et al., 2015) Implementing green supply chain practices primarily aims to reduce waste and carbon emissions. Customer awareness of the environment has grown during the last two decades. Due to that reasons, businesses are under increased pressure to cut back on hazardous chemicals, emissions and embrace green supply chain practices (Khan & Qianli, 2017). Green supply chain management practices are used to reduce waste, promote environmental conservation, develop partner collaborations, reduce costs and increase operational efficiency (T. T. H. Nguyen et al., 2020). Green purchasing, investment recovery, cooperation with customers, green packaging, green transportation are some of the green supply chain practices (Ali et al., 2017). Green packaging is a key factor in green supply chain practices.

2.4 Green Packaging

Over the past 20 years, human awareness of environmental issues has grown steadily with major economic development. People are now beginning to see how environmental changes are affecting their lives and are taking steps to combat them (Nguyen Hoai, 2017). People are starting to demand eco-friendly products and they are more concerned about their health, wealth and environment (Popovic et al., 2019). Based on their tastes, consumers of all ages evaluate the quality of the product and its packaging (Budiarti, 2020). Packaging is not just the attractive face of the product. Everything from shipping breakdown rates to retailer stocking decisions can affect package design (M. Kumar et al., n.d.). According to research by Ahmad, S., Ahmad, F., Nur, and Syed (2015) among Malaysians, there is an increasing desire for better packaging and the function of packaging has become increasingly important in attracting consumers to purchase the product (Budiarti, 2020).

The global "green concept" concern, which includes green economies, sustainability and marketing initiatives, is becoming more commonly known(Kashif & Rani, 2021). Using materials that are least harmful to the environment and living organisms is called "green packaging" (Aleenajitpong, 2019). According to Henri (2018) sustainable packaging is referred to using various names such as "green packaging design", "sustainable design", "eco-design", "design for the environment" and "eco-relevant design". According to Singh and Pandey (2018) green packaging is defined as packaging made from environmentally friendly, biodegradable or composite materials that can naturally degrade and recombine into common earth components such as carbon, oxygen and hydrogen. Green packaging, eco-packaging, eco-friendly packaging is defined as being made entirely from natural plants, recyclable or reusable, degradable and promoting sustainable development throughout its life cycle and safe for the environment as well as for people and livestock health (G. Singh & Pandey, 2018). Green packaging is recognized as a sustainable method of packaging products with a less negative impact on the environment or energy use (Wahab et al., 2021). Green packaging is being introduced primarily to safeguard both people and the environment (M. K. P. Singh et al., 2019).

Manufacturers are required under eco-design to create goods using minimal energy and materials, as well as to encourage the reuse, recycling and recovery of component materials and parts (Diab et al., 2015). Sustainable packaging improves the overall well-being of society by raising consumer health protection standards, reducing package waste and minimizing environmental impact (Selke, 2012). In addition to being eco-friendly in nature, green packaging is made from sustainable materials created using eco-friendly processes and energy-efficient stages(Wahab et al., 2021). The materials used to create green packaging can be divided into oxygen, hydrogen and carbon (Wahab et al., 2021). When designing green packaging, consider the use of non-toxic, safe materials, transportation efficiency, waste reduction, logistics and storage costs and consumer safety (Selke, 2012). The "4R1D" principle - Reduce, Reuse, Reclaim, Recycle, and Degradable is connected to green packaging(G. Singh & Pandey, 2018).Choosing eco-friendly packaging has many benefits, including a less carbon footprint, ease of disposal, biodegradability, flexibility and versatility, safety and

improved brand image, cost savings, recyclability, reuse and reduction, increased customer base, low cost and no use of plastic (Wahab et al., 2021).

According to M. Kumar et al., n.d. green packaging has 5R'S as remove , reduce , recycle, renew, re-use. Consumers perceive green packaging and their purchase intention is significantly influenced by certain factors. Among them are, for example, attitudes towards environmental issues and familiarity with green packaging(Kashif & Rani, 2021). Green packaging gives customers a positive impression, thereby developing customer loyalty and trust in the product(Wahab et al., 2021). According to(Kashif & Rani, 2021), reusable packaging increases customer satisfaction. Packaging costs 30% per ton to recycle 10% of all high-cost products that are thrown away after use. According to Kashif and Rani (2021), several key factors influence how consumers perceive green packaging and their purchasing habits. They include things like attitudes towards environmental issues and familiarity with green packaging.

2.5 Purchase Intention

Purchase intention is simply "what customers expect they will buy"(Morel et al., 2012). Green purchase intention is conceptualized as a consumer's ability and desire to prioritize environmentally friendly features over conventional ones in their purchasing decisions(Chen, 2013).According to Patel (2019), the definition of perception is the act of understanding using the senses and thinking. Cognition is the intentional recognition and interpretation of sensory stimuli that form the basis for understanding, learning and knowledge or that direct a specific action or reaction. According to Chin et al., (2019) purchase intention is defined as consumers who are knowledgeable about a product and are prepared to research it and get feedback from other consumers are said to have made a consumer purchase choice. Consumers' perception of eco-friendly products begins to influence their purchasing decision(Debora Indriani et al., 2019).

Many factors have been shown to influence consumer choice in purchasing environmentally friendly products, including values, beliefs/knowledge, needs and motives, attitudes and demographics(Mei et al., 2012).Purchase intention is influenced by emotional and rational evaluations of an environmentally friendly package(Magnier & Schoormans, 2015).How consumers feel about packaged goods usually influences their purchase decision(Magnier & Schoormans, 2015). A person's willingness to

purchase and use environmentally friendly packaged goods is known as green packaged consumer goods purchase intention(Aleenajitpong, 2019). According to Mei et al.,(2012) green purchasing is a unique pro-environmental behavior that consumers engage in to show their concern for the environment. Considering how packaging affects environmental degradation is one of the many factors influencing consumer purchasing intentions today(Prakash & Pathak, 2017). Many consumers now pay more attention to what they buy because it directly affects ecological issues.

Green purchase intention is defined as an individual's likelihood and desire to prioritize products with environmentally friendly characteristics over more conventional products when making a purchase decision(Mei et al., 2012). An individual's willingness to evaluate and favor a green product over a traditional or conventional product throughout the decision-making process is called "green purchase intention"(Factors Influencing Green Purchase Intention among University Students Charlie Albert Lasuin * and Ng Yuen Ching, 2014).Egyptian consumers were asked to answer questions about their intentions to make green purchases, and the results show that their attitudes toward such purchases can have a direct impact on both their intentions and their actual behavior(Mei et al., 2012).

3. Methodology

This chapter includes the conceptual framework of the study, the hypotheses generated within it and the methodology used to test them. This deductive nature study discusses the impact of green packaging on customer purchase intention of fast-moving consumer goods in supermarkets. The deductive technique relies on what is previously known and done on the topic of study as well as relevant ideas related to the topic to help the researcher create a hypothesis(T. T. H. Nguyen et al., 2020). This research indicated the relationship between green packaging and consumer purchase intention on environmental concern about green packaging, customer attitudes towards eco-packaging, willing to pay for eco-packaging.

This study used a cross-sectional research design. Data from numerous cases must be collected for the cross-sectional approach. When conducting cross-sectional research, we must use two or more variables and collect all the data at the same time. The data evaluation process is done using a quantitative method. Because we chose to adopt a

quantitative strategy and consequently develop a social survey, the sampling technique used in the research process is an important consideration(T. T. H. Nguyen et al., 2020). Primary data have been gathered via a survey questionnaire. Specific information defines a significant relationship that can be predicted between variables and occurs in the desired outcome; therefore, the overall research techniques should be justified by verifying the appropriate study approach and methodology in this investigation. Descriptive statistics were used to measure all the collected data. Multiple regression analysis used to assess the relationship between the dependent and independent variables. The statistical data analysis software package SPSS, also known as IBM SPSS Statistics. This study used SPSS software version; 26. In this case, this research used SPSS Statistics, a specialized program for logical statistical analysis, to perform statistical tests.

3.1 Sampling Method

The initial stage of the sampling process is in which a sample is selected from a population(Morel et al., 2012). This investigation focuses on the convenience sampling method. The convenience sampling method is a non-probabilistic sampling method. Convenience sampling will be used due to the feasibility and schedule constraints of the study. According to Morel et al.,(2012) convenience sampling is defined as a "sampling method" in which the sample is selected for the researcher's convenience and is often used in the early stages of research because it "enables a moderate number of respondents to be interviewed in a short period".

This strategy was chosen due to the difficulty of data collection in the current situation. The researcher distributed physical surveys to consumers. The "Sample Frame" included only the top 4 supermarkets in the Colombo district including Cargills Food City, Keells, Arpico and Glomark supermarket.

4. Findings and Discussion

This research investigated the impact of customer purchase intention on green-packaged fast-moving consumer goods. Many researchers have previously noted the literature review that investigated the effect of consumer purchase intention on green-packaged products in different industries and nations. The results of the study collected through

the physical questionnaire distributed to the selected sample are covered in more detail in chapter four.

The purpose of this chapter is statistically interpreted (with tables and figures) the impact of consumer purchase intention on fast-moving consumer goods with green packaging according to what has already been discussed in the literature. To achieve this, 322 responses were collected from customers using fast-moving consumer goods with green packaging in 4 major supermarkets in the Colombo district. This chapter will assist in the analysis and presentation of data in accordance with the objectives of the study. Reliability, correlation and regression are examined in this chapter.

3.1 Correlation Analysis

The correlation coefficient is a measure of how closely the movements of two variables are related to each other. A positive relationship can be determined if the correlation coefficient is greater than zero. If the correlation value is 0, there is no relationship between the variables, and if it is negative, there is a negative relationship between the variables. This type of study is useful when a researcher wants to find out if there are potential relationships between variables. The correlation coefficient measures the strength of the linear relationship between two variables.

A positive relationship can be determined if the correlation coefficient is greater than zero. If the correlation value is 0, there is no relationship between the variables, and if it is negative, there is a negative relationship between the variables. The values of the correlation coefficient vary from -1 to +1. To put it another way, the value cannot be greater than +1 or less than -1. +1 indicates a perfect positive correlation between the variables, and -1 means a perfect negative correlation between the variables.

Table 1: Correlation between customer purchase intention and willing to pay for green packaged fast moving consumer goods

Dependent Variable	Independent Variable	Pearson Correlation	Significance of Relationship
Purchase Intention	Willing to pay for eco-packaged fast-moving consumer goods	0.902	0.000

Table 1 shows that customer purchase intention and willingness to pay for green-packaged fast-moving consumer goods in supermarkets of the Colombo district have a

positive and strong relationship. Furthermore, the correlation is 90.2%. As the significance value is less than 0.01 (0.000 < 0.01), there is a significant relationship between customer purchase intention and willingness to pay for eco-packaged fast-moving consumer goods.

Table 2: Correlation between customer purchase intention and environmental concern about green-packed fast-moving consumer goods

Dependent Variable	Independent Variable	Pearson Correlation	Significance of Relationship
Purchase Intention	Environment concern about green-packed fast-moving consumer goods	0.924	0.000

Table 2 shows that there is a positive and strong relationship between consumer purchase intention and environmental concern about fast-moving consumer goods in supermarkets in the Colombo district with green packaging and the relationship is 92.4%. There is a significant correlation between consumer purchase intention and environmental concern about fast-moving consumer goods with green packaging as the significance value is less than 0.01 (0.000 < 0.01).

Table 3: Correlation between customer purchase intention and consumer Attitudes towards Green Packaged Fast-Moving Consumer goods

Dependent Variable	Independent Variable	Pearson Correlation	Significance of Relationship
Purchase Intention	Consumer Attitudes Towards to Green Packaged Fast-Moving Consumer goods	0.916	0.000

Table 3 shows that there's a positive and strong relationship between customer purchase intention and consumer attitude towards fast-moving consumer goods with green packages in supermarkets in the Colombo district. The relationship is 91.6%. As the significance value is less than 0.01 (0.000 < 0.01), there is a significant relationship between customer purchase intention and consumer attitude toward green-packaged fast-moving consumer goods.

3.2 Regression Analysis

A more advanced version of simple linear regression is multiple regression analysis. Effects of changes in independent variables on the dependent variable were explained

using regression analysis (M. K. P. Singh et al., 2019).The coefficient of correlation relates to the R value of a summary of a multiple regression model. The R value simply indicates the accuracy of the prediction of the dependent variable. R square is a statistical technique used to quantify how well a model fits the data (Kashif & Rani, 2021).

The number of independent variables considered in the model is considered while adjusting the R square value. The coefficient of determination (R squared) shows the amount of variation in the outcome of the dependent variable that can be explained by changes in the independent variable.

According to the table R square value is 0.875 which is greater than 0.5. Therefore, there's a strong model fit. This R-squared value accounts for 87.5% of the variance of the dependent variable when all three independent variables are considered. All three independent variables in this model have an adjusted R squared of 0.874, which explains 87.4% of the explanatory power. This study's significant value is 0.000, which is less than 0.01 (0.000 < 0.01).

Table 4: Regression and hypothesis testing

Model Summary				
R Square	0.875			
Adjusted R square	0.874			
Model Significance	0.000			
Hypothesis test		B Coefficient (Beta)	Significance	Accept/Reject
H1: Willing to pay for green packaged fast moving consumer goods have a positive effect on customer purchase intention of supermarkets in the Colombo district.		0.280	0.000	Accept

H2: Environment concerns for green packaged fast-moving consumer goods have a positive effect on customer purchase intention of supermarkets in the Colombo district.	0.594	0.000	Accept
H3: Customers' attitudes for green packaged fast-moving consumer goods have a positive effect on customer purchase intention of supermarkets in the Colombo district.	0.036	0.776	Reject

3.3

3.4 Hypothesis Testing

A statistical approach known as hypotheses testing is used to test hypothesis established using a conceptual framework. If the P value for the alternative hypothesis is less than 0.01, it is accepted. If the value exceeds 0.01 then the null hypothesis is accepted.

H1: Willing to pay for green packaged fast moving consumer goods have a positive effect on customer purchase intention of supermarkets in the Colombo district.

In the regression results, the value for willingness to pay for eco-packaged fast-moving consumer goods is less than 0.01 at a significant level (0.000 < 0.01). Therefore, the hypothesis is accepted. In addition, the beta coefficient is 0.280, which indicates that willingness to pay for green-packaged fast-moving consumer goods has a 28% impact on consumer purchase intentions in supermarkets in the Colombo district. According to the table, customer purchase intention of green packaged fast-moving consumer goods in supermarkets in the Colombo district can increase 0.280 units therefore willing to pay for green-packaged fast-moving consumer goods can enhance by unit 1.

H1: Environment concerns for green packaged fast-moving consumer goods have a positive effect on customer purchase intention of supermarkets in the Colombo district.

In the regression results, the value for environmental concern about green-packed fast-moving consumer goods is less than 0.01 at a significant level (0.000 < 0.01). Therefore, the hypothesis is accepted. In addition, the beta coefficient is 0.594, which indicates that environmental concerns for green-packaged fast-moving consumer goods have a 59.4% impact on customer purchase intention in supermarkets in the Colombo district. According to the table 4, customer purchase intention of green-packaged fast-moving consumer goods in supermarkets in the Colombo district can increase by 0.594 units therefore Environment concerns about green-packaged fast-moving consumer goods can enhance by unit.

H1: Customers' attitudes toward green-packaged fast-moving consumer goods have a positive effect on customer purchase intention of supermarkets in the Colombo district.

In the regression results, the value for customer attitude toward green-packaged fast-moving consumer goods is higher than 0.01 (0.776 > 0.01). Therefore, the hypothesis is not accepted. But Beta value of this hypothesis is positive. It is key to disprove the hypothesis that consumers are not much knowledgeable about this area.

5. Limitations and Recommendations for Future Researchers

Although this research study has significant limitations, it has the potential to explore an area of further interest. This research is conducted in the Colombo district in Sri Lanka. Therefore, this research can be conducted in other cities in Sri Lanka. The population of this study was drawn from supermarkets only, but similar research could be conducted on consumers in other industries. There're many other types of packaging, but we did not research any of them; Future studies should focus on a specific type of packaging so that the findings are more realistic and companies can focus on more practical forms of packaging.

6. Conclusion

After globalization environment pollution has become a major problem. Therefore, organizations adapt green supply chain practices for their organizations. Green packaging is a one of main component of green supply chain practices. According to Singh and Pandey (2018) green packaging is defined as packaging made from

environmentally friendly, biodegradable or composite materials that can naturally degrade and recombine into common earth components such as carbon, oxygen and hydrogen. This research is about how impact green packaging of fast-moving consumer goods to the purchase intention in supermarkets in Colombo district. Primary data for this research collected from 322 individuals through a physical survey and secondary data collected from previous research papers / books and articles.

RQ1. What is the relationship between green packaging and customer purchase intention?

According to the previous kinds of literature, green packaged products and customer purchase intention have a positive relationship. This study measures the relationship between green packaged products and consumer purchase intention using the variables which are willing to pay more for eco-packaged fast-moving consumer goods and environmental concern towards eco-packaged fast-moving consumer goods. Correlation analysis shows strong positive relationship with 0.902 Pearson correlation for willingness to pay and 0.924 for environment concern. Significant value for both variables is less than 0.01 (Significant value – 0.000). According to the regression analysis, willingness to pay and environment concern have a positive impact on purchase intention of FMCG in Colombo district supermarkets.

RQ2. How is the customer's awareness of green packaging?

In this research consumer awareness measures using the variable which is consumer attitudes towards green packaged goods. According to the correlation analysis of the consumer attitude variable, Pearson's correlation value is 0.916 which is 91.6%. The significance value is 0.000. That means the purchase intention of green-packaged fast-moving consumer goods and consumer attitude has a strong positive relationship. That means consumers have a positive attitude toward green packaging products. According to the hypothesis testing, the relevant hypothesis's significant value is 0.776 which is more than 0.01. Here significance value is higher than the Alpha value. Therefore, the hypothesis is rejected.

RQ3. How do demographic factors of consumers affect the purchase intention of green-packed FMCG?

The study found that consumers' purchase intentions are influenced by demographic characteristics. According to the frequency analysis of this study, females are more buying green packaged fast-moving consumer goods than males. That means female consumers have more attention and knowledge about the concept of green packaging than males. As a percentage of the sample size, 56.5% of females are buying green-packaged fast-moving consumer goods from supermarkets in the Colombo district. From the sample size, bachelor's degree holders are buying green-packaged fast-moving consumer goods more than others who have other educational qualifications. Consumers who have a monthly income of Rs.110 000 to Rs.175 000 buy more green packaged goods than others. That means high-income consumers use products with green packaging more than others.

REFERENCES

Ahmed, N., Li, C., Khan, A., Qalati, S. A., Naz, S., & Rana, F. (2021). Purchase intention toward organic food among young consumers using theory of planned behavior: role of environmental concerns and environmental awareness. Journal of Environmental Planning and Management, 64(5), 796–822. https://doi.org/10.1080/09640568.2020.1785404

Aleenajitpong, N. (2019). Attitude Towards Green Packaging and Its Impact on Purchase Intention of Green Packaged Consumer Products among Undergraduates in Bangkok Metropolitan, thailand. SSRN Electronic Journal, January 2013. https://doi.org/10.2139/ssrn.3373526

Ali, A., Bentley, Y., & Cao, G. (2017). GREEN SUPPLY CHAIN MANAGEMENT - Food for Thought ? 20(1), 22–38. https://doi.org/10.1080/13675567.2016.1226788

Amoako, G. K., & Dzogbenuku, R. K. (2019). Do green knowledge and attitude influence the youth ' s green purchasing ? Theory of planned behavior. https://doi.org/10.1108/IJPPM-12-2019-0595

Becker, F. G., Cleary, M., Team, R. M., Holtermann, H., The, D., Agenda, N., Science, P., Sk, S. K., Hinnebusch, R., Hinnebusch A, R., Rabinovich, I., Olmert, Y., Uld, D. Q. G. L. Q., Ri, W. K. H. U., Lq, V., Frxqwu, W. K. H., Zklfk, E., Edvhg, L. V, Wkh, R. Q., … فاطمی,)2015(.ح. No 主観的健康感を中心とした在宅高齢者における 健康関連指標に関する共分散構造分析 Title. Syria Studies, 7(1), 37–72. https://www.researchgate.net/publication/269107473_What_is_governance/link/548173

090cf22525dcb61443/download%0Ahttp://www.econ.upf.edu/~reynal/Civil wars_12December2010.pdf%0Ahttps://think-asia.org/handle/11540/8282%0Ahttps://www.jstor.org/stable/41857625

Budiarti, novi yulia. (2020). No 主観的健康感を中心とした在宅高齢者における 健康関連指標に関する共分散構造分析 Title. Sustainability (Switzerland), 4(1), 1–9. https://pesquisa.bvsalud.org/portal/resource/en/mdl-20203177951%0Ahttp://dx.doi.org/10.1038/s41562-020-0887-9%0Ahttp://dx.doi.org/10.1038/s41562-020-0884-z%0Ahttps://doi.org/10.1080/13669877.2020.1758193%0Ahttp://sersc.org/journals/index.php/IJAST/article

Chen, L. (2013). A Study of Green Purchase Intention Comparing with Collectivistic (Chinese) and Individualistic. Information Management and Business Review, 5(7), 342–346.

Chin, T. A. N. H. binti M. L. Z. S. A. M., Farrah Merlinda Muharam, O., & Hon Tat, H. (2019). Effect of Green Brand Positioning, Knowledge, and Attitude of Customers on Green Purchase Intention. Journal of Arts & Social Sciences, 3(1), 23–33.

Chiu, J. Z., & Hsieh, C. C. (2016). The impact of restaurants' green supply chain practices on firm performance. Sustainability (Switzerland), 8(1), 1–14. https://doi.org/10.3390/su8010042

Debora Indriani, I. A., Rahayu, M., & Hadiwidjojo, D. (2019). The Influence of Environmental Knowledge on Green Purchase Intention the Role of Attitude as Mediating Variable. International Journal of Multicultural and Multireligious Understanding, 6(2), 627. https://doi.org/10.18415/ijmmu.v6i2.706

Diab, S. M., AL-Bourini, F. A., & Abu-Rumman, A. H. (2015). The Impact of Green Supply Chain Management Practices on Organizational Performance: A Study of Jordanian Food Industries. Journal of Management and Sustainability, 5(1), 149–157. https://doi.org/10.5539/jms.v5n1p149

Dinca, D., & Rahib, A. (n.d.). Related papers CONSUMER SWIT CHING BEHAVIOUR: A ST UDY OF SHAMPOO BRANDS vi khong INFLUENCE OF RELIGION ON SHOPPING BEHAVIOUR OF CONSUMERS-AN EXPLORAT ORY ST UDY Asif Jeelani Global Journal of Management and Business Research Role of Packaging on Consumer. www.abhinavjournal.com

Henri. (2018). The influence of sustainable packaging on brand perception in fast-moving consumer goods- Comparing perceptions of international consumers. Angewandte Chemie International Edition, 6(11), 951–952.

Kashif, M., & Rani, T. (2021). Customers' Attitude Towards Green Packaging : Journal of

Marketing Strategies, 3(1).

Khan, S. A. R., & Qianli, D. (2017). Impact of green supply chain management practices on firms' performance: an empirical study from the perspective of Pakistan. Environmental Science and Pollution Research, 24(20), 16829–16844. https://doi.org/10.1007/s11356-017-9172-5

Kumar, B. (2012). INDIAN INSTITUTE OF MANAGEMENT AHMEDABAD-380 015 INDIA A Theory of Planned Behaviour Approach to Understand the Purchasing Behaviour for Environmentally Sustainable Products A Theory of Planned Behaviour Approach to Understand the Purchasing Behaviour for.

Kumar, M., Agarwal, A., Singh, P., & Singhal, A. K. (n.d.). Green Packaging and Marketing in Promoting Agribusiness. 208002.

Magnier, L., & Schoormans, J. (2015). Consumer reactions to sustainable packaging: The interplay of visual appearance, verbal claim and environmental concern. Journal of Environmental Psychology, 44, 53–62. https://doi.org/10.1016/j.jenvp.2015.09.005

Munasinghe, P. M., & Shantha, A. A. (2021). Factors influencing the Purchase Intention of Green Packaging among Millennials in Gampaha District of Sri Lanka. Sri Lanka Journal of Marketing, 7(2), 49. https://doi.org/10.4038/sljmuok.v7i2.64

Nguyen, A. T., Yến-Khanh, N., & Thuan, N. H. (2021). Consumers' Purchase Intention and Willingness to Pay for Eco-Friendly Packaging in Vietnam. In Environmental Footprints and Eco-Design of Products and Processes (Issue September). https://doi.org/10.1007/978-981-16-4609-6_11

Nguyen Hoai, A. (2017). Consumer's Buying Behaviour Towards Green Packaging in Finland. Vaasan Ammattikorkeakoulu University of Applied Sciences International Business, 47–56.

NGUYEN, N. T., NGUYEN, L. H. A., & TRAN, T. T. (2021). Purchase Behavior of Young Consumers Toward Green Packaged Products in Vietnam. Journal of Asian Finance, Economics and Business, 8(1), 985–996. https://doi.org/10.13106/jafeb.2021.vol8.no1.985

Nguyen, T. T. H., Pham, T. L., Phan, T. T. H., Than, T. T., & Nguyen, T. Q. A. (2020). Impact of green supply chain practices on financial and non-financial performance of Vietnam's tourism enterprises. Uncertain Supply Chain Management, 8(3), 481–494. https://doi.org/10.5267/j.uscm.2020.4.004

Pang, S. M., Tan, B. C., & Lau, T. C. (2021). Antecedents of consumers' purchase intention towards organic food: Integration of theory of planned behavior and protection motivation theory. Sustainability (Switzerland), 13(9). https://doi.org/10.3390/su13095218

Photcharoen, C., Chung, R., & Sann, R. (2020). Modelling Theory of Planned Behavior on Health Concern and Health Knowledge towards Purchase Intention on Organic Products. International Business Research, 13(8), 100. https://doi.org/10.5539/ibr.v13n8p100

Popovic, I., Bossink, B. A. G., & van der Sijde, P. C. (2019). Factors influencing consumers' decision to purchase food in environmentally friendly packaging: What do we know and where do we go from here? Sustainability (Switzerland), 11(24), 1–22. https://doi.org/10.3390/SU11247197

Prakash, G., & Pathak, P. (2017). Intention to buy eco-friendly packaged products among young consumers of India: A study on developing nation. Journal of Cleaner Production, 141, 385–393. https://doi.org/10.1016/j.jclepro.2016.09.116

Qin, X., Godil, D. I., Sarwat, S., Yu, Z., Khan, S. A. R., & Shujaat, S. (2021). Green practices in food supply chains: evidence from emerging economies. Operations Management Research. https://doi.org/10.1007/s12063-021-00187-y

Randiwela, P. (2017). Consumer Buying Behaviour and Attitudes Towards Eco- Friendly Fast-Moving Consumer Goods – Cosmetics & Personal Care Products CONSUMER BUYING BEHAVIOR AND ATTITUDES TOWARDS ECO- FRIENDLY FAST MOVING CONSUMER GOODS – COSMETICS & PERSONAL Pradeep Randiwela (Issue January).

S, M. V, & Singh, R. K. (2019). Drivers for Green Supply Chain Management In Food & Grocery Retail – A Study. Think India, 22(2), 288–295. https://doi.org/10.26643/think-india.v22i2.8729

Samarasinghe, G. D., & Ahsan, F. J. (2014). Impact of Consumers' Moral Self- Identity on Green Purchase Decisions of Fast Moving Consumable Goods (FMCG). Colombo Business Journal, 5(1), 1–15.

Saut, M., & Saing, T. (2021). Factors affecting consumer purchase intention towards environmentally friendly products: a case of generation Z studying at universities in Phnom Penh. SN Business & Economics, 1(6), 1–20. https://doi.org/10.1007/s43546-021-00085-2

Selke, S. E. M. (2012). Green packaging. Food Engineering Series, December, 443–468. https://doi.org/10.1007/978-1-4614-1587-9_16

Sezen, B., & Çankaya, S. Y. (2017). Green supply chain management theory and practices. Operations and Service Management: Concepts, Methodologies, Tools, and Applications, December, 118–141. https://doi.org/10.4018/978-1-5225-3909-4.ch006

Shukla, S. (2019). A Study on Millennial Purchase Intention of Green Products in India: Applying Extended Theory of Planned Behavior Model. Journal of Asia-Pacific Business,

20(4), 322–350. https://doi.org/10.1080/10599231.2019.1684171

Singh, G., & Pandey, N. (2018). The determinants of green packaging that influence buyers' willingness to pay a price premium. Australasian Marketing Journal, 26(3), 221–230. https://doi.org/10.1016/j.ausmj.2018.06.001

Singh, M. K. P., Rajendran, S. D., & Wahab, S. N. (2019). Malaysian consumers' preference for green packaging. International Journal of Society Systems Science, 11(4), 312. https://doi.org/10.1504/ijsss.2019.10025067

Siyambalapitiya, J., Perera, J., & Rathnayake, P. A. (2020). Investigation of the Impact of Green Marketing Tools on Customer Purchase Intention of Fast Moving Consumer Goods: with Special Reference to Youth Sector. International Conference on Marketing Management, December. https://www.researchgate.net/publication/347711652

Sreen, N., Purbey, S., & Sadarangani, P. (2018). Impact of culture, behavior and gender on green purchase intention. Journal of Retailing and Consumer Services, 41(July 2017), 177–189. https://doi.org/10.1016/j.jretconser.2017.12.002

Sugathadasa, P. T. R. S., Hewage, H. C., & Perera, H. N. (2021). FACTORS INFLUENCING THE IMPLEMENTATION OF GREEN SUPPLY CHAIN MANAGEMENT PRACTICES IN A SUPERMARKET: A SRI LANKAN CASE. 72–74.

MACHINE LEARNING MODEL FOR POWERTRAIN MONITORING AND PREDICTIVE ANALYSIS FOR AN AUTONOMOUS GUIDED VEHICLE

ASHLY L G I[1], MANATHUNGA M A D C[1], BUDDHIKA R A P[1], PERERA C[2]

[1]*Department of Electrical, Electronic and Computer Systems Engineering*

[2]*Department of Mechatronic and Industrial Engineering*

NSBM Green University, Sri Lanka

[1]iman.a@nsbm.ac.lk, [1]madcmanathunga@students.nsbm.ac.lk,

[2]prabhath.b@nsbm.ac.lk, [2]chandana.p@nsbm.ac.lk

Abstract

To improve the reliability of powertrain systems in Autonomous Guided Vehicles (AGVs), this research has presented an innovative approach utilizing an IoT-based real-time monitoring system with predictive analysis output. AGVs, often face disruptions due to powertrain failures, particularly in batteries and motors. These failures can lead to operational downtime and increased maintenance costs. Existing methods have not adequately addressed these challenges, often relying on simulations that lack real-world applicability. In this research, a novel system is introduced that employs the Message Queuing Telemetry Transport (MQTT) protocol for reliable data transmission, even in areas with poor connectivity. By continuously monitoring key parameters such as current, voltage, and temperature, the system provides a comprehensive overview of powertrain health. Additionally, machine learning models and Kalman filter algorithm are integrated to offer real-time predictions of motor and battery health, using actual AGV data to enhance accuracy and reliability. The results demonstrate the system's capability to detect and diagnose faults effectively, leading to improved operational efficiency. This approach not only fills the gaps in current literature but also sets a new standard for AGV powertrain monitoring by offering a robust and practical solution to fault detection and diagnosis. The implications of this research are significant, promising to reduce downtime and enhance the resilience of AGVs.

Keywords: Autonomous Guided Vehicles, Powertrain failures, Internet of Things, Machine learning

1. *Introduction*

Autonomous Guided Vehicles are advanced systems developed by integrating various technologies and multiple components, which enable them to move around independently and handle a variety of tasks with much efficiency (Wen-Qiang Zou, 2021). The vehicles in question play an important role in automating a myriad of operations in quite a few industries, increasing their productivity and efficiency (M. Zhong, 2020) (Dares, et al., 2020). They autonomously transport materials to places, hence reducing the intervention of humans in the workflow, minimizing inaccuracies, and optimizing work (Shen, Kilic, & Reuss, 2018) (Ma, Ghasemi, & Song, 2017). Today, AGVs are required necessarily in industries such as manufacturing, warehousing, and logistics, in which they play a very significant role in operational effectiveness and cost reduction.

2. *Literature Review*

Although fully endowed with a lot of benefits, the faultless operation of AGVs can still be compromised by failures, particularly those related to their powertrain, which involves only the battery and motor systems (K. Krot, 2022) (S. Safavi, 2021). The powertrain is a part of the vehicle that guarantees the AGV's mobility and functionality. Any sudden failure in this system may mean operational downtime, loss in production, and possible safety problems (S. Safavi, 2021). Therefore, it is of essence to monitor the health of the powertrain to sustain the reliability and efficiency of operations performed by AGVs. A lot of research were done on the topic of monitoring single parameters of powertrain components, where techniques of machine learning and deep learning are applied to predict faults (S. Safavi, 2021), (Wolf, 2020), (E. Adi, 2020). However, such studies often do not take into consideration the interaction and synergies between these two devices to obtain a deeper view of the health status of the AGV.

It is obvious that the AGVs are complex systems depending highly on the powertrain, where smart monitoring systems are increasingly required to give a predictive analysis of the vehicle's health. Traditional methods of monitoring look in isolation at the battery and motor parameters, missing the complex dynamics occurring between them (K. Krot, 2022) (S. Safavi, 2021) (Wolf, 2020) (E. Adi, 2020). This is attainable via advanced

technologies that can incorporate IoT and machine learning to support a multi-parameter monitoring approach that provides a much-needed view into the health and performance of the AGV. This holistic approach allows better fault detection capabilities, enabling proactive maintenance strategies that reduce downtime and extend the life of the AGV.

Recent publications on AGVs have several limitations and shortcomings, mainly because of the inadequacy of suitable methods for monitoring the powertrain of AGVs and detecting faults in it. For example, one of the works developed a method for fault detection and diagnosis based on machine learning approach while it did not address powertrain system that is one of the most important components for AGV performance and durability (Dares, et al., 2020). Another research work brought forth a powertrain energy management system which focused on energy minimization but did not incorporate the identification of the motors (Wolf, 2020). Additionally, a method was presented to make reliable powertrain systems for automated automobile, which employed the data of voltage, current, and position sensor; however, this was performed only in simulations using MATLAB/Simulink (M. Zhong, 2020). These simulations lack the real-life issues and issues arising from real-life AGVs in the Operational Environment.

However, this research aims at the powertrain, with emphasis on both battery and motors as the primary objectives of the research. There is always the problem of communication in remote areas that is why this research has implemented the IoT-based real-time monitoring system of the main powertrain current, voltage, and temperature using MQTT protocol. This system also has included machine learning and Kalman filter based prediction system based on actual AGV data. This approach does not only help to fill the gaps of current literature but also promote the reliability and operational efficiency of AGVs by introducing a highly reliable and sophisticated monitoring system which can systematically and accurately detect as well as diagnose any fault arise in the powertrain components.

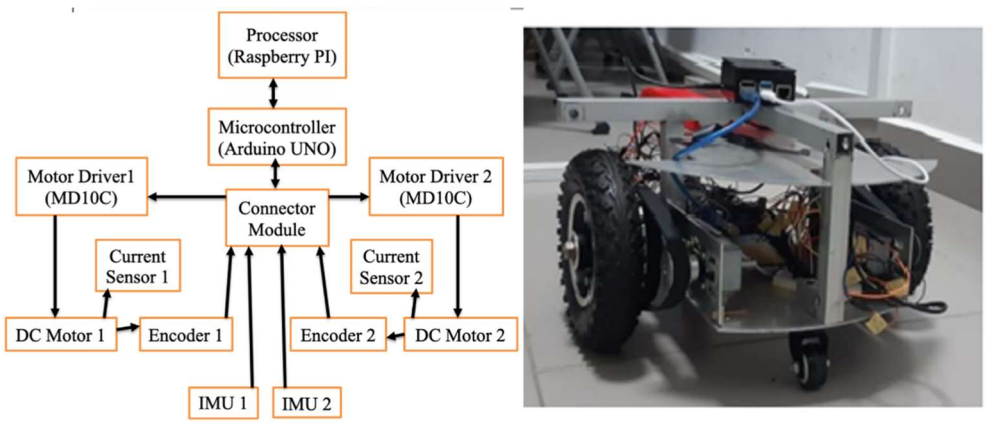
3. Methodology

3.1. Outline of Research Methods

In this research, a quantitative approach to monitoring and analysis of the critical powertrain parameters for an autonomous guided vehicle has been followed. The prime objective of the research is to establish a reliable system for real-time monitoring and predictive analysis of AGV health. A literature review identified the key parameters: current, voltage, and temperature are very essential parameters in assessing the condition of the AGV's battery and motors. The AGV used for this study is shown in Figure 1.

The AGV chosen for the study is a small scale AGV with two wheels driven by two dedicated DC motors with the support of a caster wheel. The AGV can carry a load not more than 5kg at a constant speed of 1.5 ms-1 or less. To ensure that the collected data will not be affected by the extreme running conditions of the AGV, it was decided to limit the maximum load applied to 4kg and to limit the constant speed to 1ms-1.

Figure 1: AGV hardware architecture and the physical view



For the same, a real-time monitoring system based on IoT has been developed, which tracks the present consuming current, supply voltage, and temperature of both motors with respect to the discharging current, output voltage, and temperature of the battery. Since the selected AGV is configured with two motors and a battery, the monitoring

system will track the powertrain parameters of both motors and the battery simultaneously.

MQTT protocol was used to send monitored data to the Node-RED dashboard. Parameters were displayed in real time numerically and graphically with a timestamp to identify variations of parameters over time. Furthermore, this obtained information was saved periodically to a local CSV file for further analysis. In this dataset, two different machine learning models were developed and trained: one for predicting the health condition of the right motor, another for the left motor, and used Kalman filter based algorithm for predicting the State of Charge of the battery.

3.2. IoT System Design and Architecture

Readings from relevant sensors were taken by applying serial communication methods to the edge device. After data was collected to the edge device then they were published to the internet through Wi-Fi. For this MQTT protocol has been used. IoT system architecture is denoted in the Figure 2. Several sensors have used to measure parameters that is mentioned in the Figure 3.

3.3. Data collection conditions

The AGVs mostly move from point to point by taking orders of movement to certain locations on a map generated by them. They apply in different industries, and one common application is the delivery of goods around warehouses. The application in this study of the AGV as a delivery robot focuses on the point-to-point movement with the carrying of items. The movement was always from one point to another with an item in tow, thus continuous in nature, just as the warehouse delivery tasks.

There exist variations of conditions on how an AGV moves, either with varying speed or by carrying mass. Varying the AGV's carrying mass at a constant speed was selected for this research. This was chosen in view of how warehouse delivery AGVs normally work: moving with a constant speed and a changing carrying mass. In this experiment. Furthermore, data for a motor with a driver failure were recorded, which corresponded to the motor used in the AGV under study. Information was collected to train a machine learning model that would classify motor driver failures if they do happen. As a summary data were collected under following conditions.

- No load condition
- With driving wheels (Without touching floor)
- Without carrying a mass
- AT low load (1Kg) constant speed ($1ms^{-1}$) condition
- AT medium load (2Kg) constant speed ($1ms^{-1}$) condition
- AT high load (4Kg) constant speed ($1ms^{-1}$) condition
- Stall condition
- Motor driver failure condition

Figure 2: IoT System Architecture

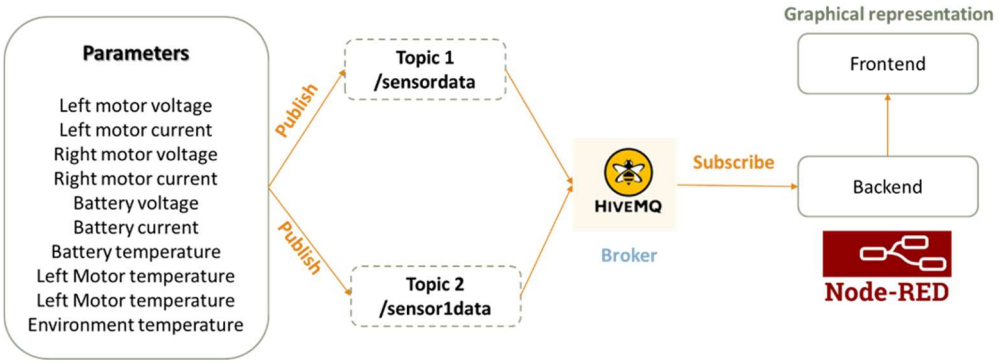
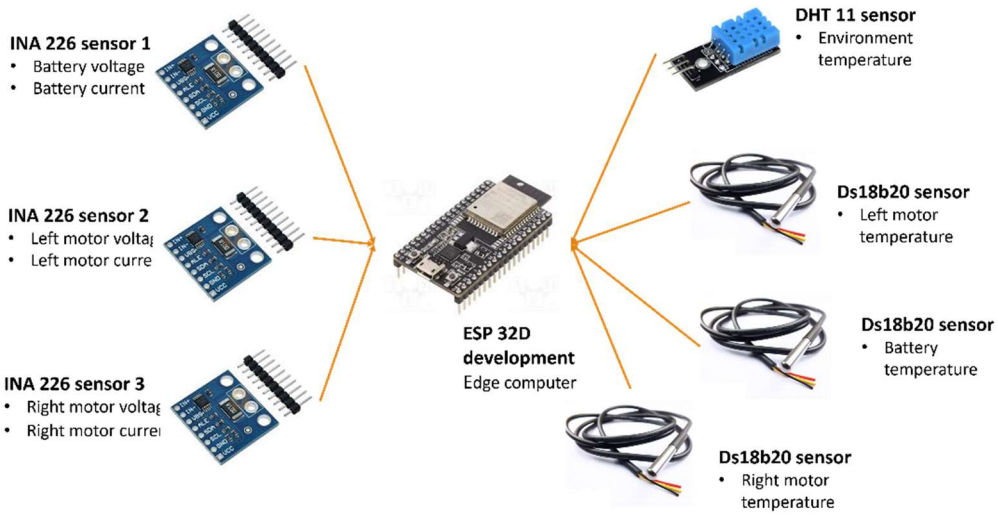


Figure 3: Sensors which used to implement the system



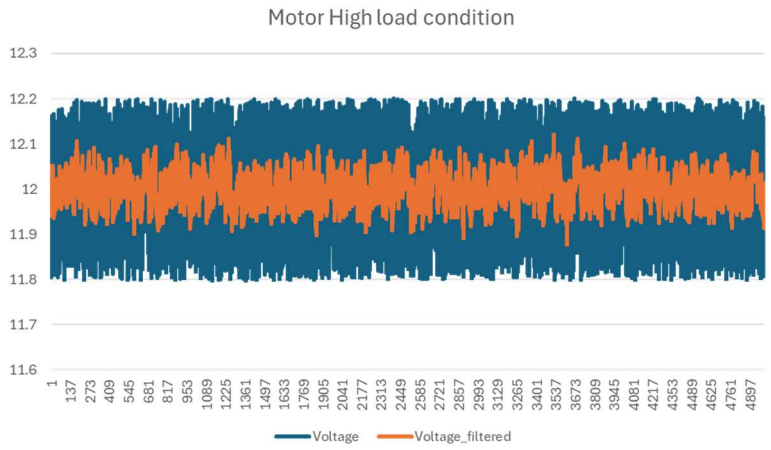
These conditions were set up for the study to ensure that all major operating conditions are covered effectively to thorough the scope of the study. Given that the AGV used for the study is a small scale AGV, the constant speed was chosen to be 1ms-1 and the load levels were chosen as given in the list above.

Both motors temperature, consuming current, supply voltage and for battery voltage, discharging current and temperature and environment temperature have been collected under each condition that above mentioned.

3.4. Data Preprocessing

Data preprocessing must be performed before using these data to come up with results or machine learning model training because typically data can be contaminated with noise values. An external Kalman filter was used to cancel out the noise of the battery voltage without changing flow of the data in this preprocessing step showed in Figure 4. With the assumption that the noise is Gaussian and considering the fact that the measurements are taken from multiple sensors, the Kalman filter was chosen for filtering. According to the graph, the distortion due to the added noise has been mitigated by the external filters.

Figure 4: Data filtering done using external filters



3.5. Motor health prediction model

This forecast was made using a supervised learning technique, in which case classification algorithms must be applied to predict the health status of the motor. For

that, a random forest classifier was chosen. Given the fact that there are readings to be taken from multiple sensors and the impact of any missing sensor data could be severe, an algorithm that can perform under those situations was the main concern. As such, the random forest classifier was the best option to select. The most selected algorithm to build multiple decision trees when training implies selecting classification classes for classification tasks. This approach was chosen based on its robustness with respect to overfitting, handling of high-dimensional data, and ability to capture complex interactions among features.

3.6. State of Charge (SOC) prediction algorithm

For SOC estimation Kalman filter based real time python script was used. Kalman filter is a popular method that has been used in real time SOC prediction applications because it can handle noisy sensor readings and uncertainties (Q. Wang, 2022). Since the ESP is publishing real-time battery data (including current, voltage, and temperature) with noisy sensor readings, using a Kalman filter is a better approach to process and refine the data.

The SOC estimation process has two primary steps such as prediction step and the update step. The predication step denotes how much SOC is used based on the current flow and it can be represented by standard equation.

$$\bar{x}_k = x_{k-1} - \frac{I_k}{C} \qquad (1)$$

Where:

- $\bar{x}_k-$ is the predicted SOC
- I_k is the battery current (in amperes)
- C is the battery capacity (in Ah)

The update step corrects the SOC using the voltage measurement as a reference. This also be denoted by an equation.

$$z_k = \frac{V_k - V_{cutoff}}{V_{full\ charg} - V_{cutoff}} \qquad (2)$$

Where:

- z_k is the voltage-derived SOC estimate
- $V_k$is the measured battery voltage.
- $V_{cutoff}$is the cut-off voltage (typically the lowest voltage at which the battery operates)
- $V_{full\ charge}$ is the full charge voltage

We need Kalman gain here because of the adjust weight of predictive SOC vs voltage.

$$K_k = \frac{P_{k-1}}{P_{k-1} + R} \qquad (3)$$

Where:

- $K_k$is the Kalman gain.
- $P_{k-1}$is the error in the previous SOC estimate
- R is the measurement noise covariance (uncertainty in the sensor readings)

Finally, corrected SOC can be calculated from following equation.

$$x_k = \bar{x}_k + K_k(z_k - \bar{x}_k) \qquad (4)$$

All those equations are standard equation that were used in existing publications (Q. Wang, 2022), (P. Shrivastava, 2019) and for this research same algorithm was deployed in a python script and customize parameters according to LiPo battery model and according to nonlinear behavior of the LiPo battery.

4. *Results*

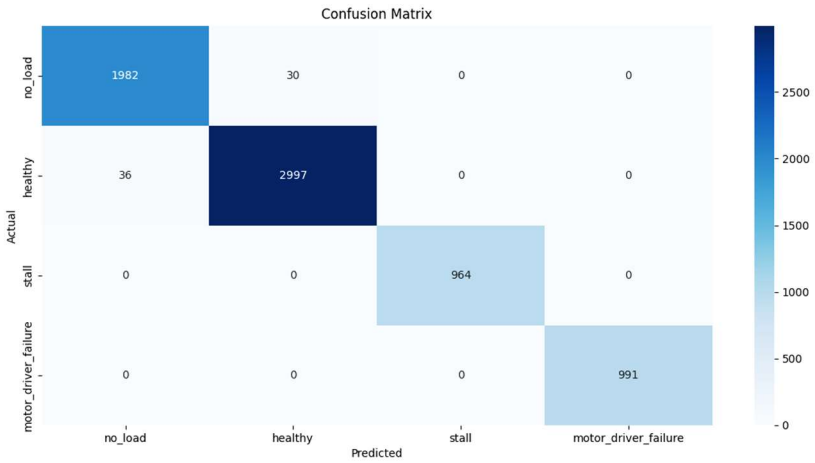
4.1. Motor Health Condition Prediction Analysis

As mentioned in the methodology part random forest machine learning technique was used in this model. When considering validation of a machine learning model there are several important factors to be considered. Such as classification report, cross-Validation Accuracy Scores, Average Cross-Validation Accuracy and Confusion matrix. For this motor predictive analysis part was done based on this confusion matrix. By looking at this confusion matrix, the number of classes that means number of

prediction outcomes have increased and optimized machine learning model version by version.

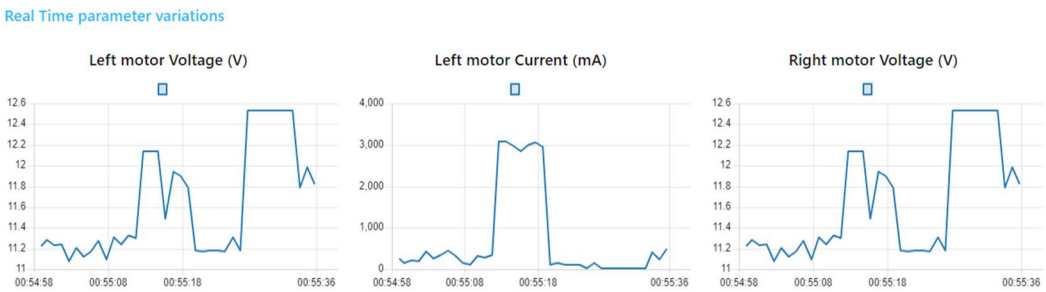
In the version one model there were only four prediction outcomes and confusion among them is very low showed in the Figure 5. Only confusion had happened in between no load and healthy classes. That means it can furtherly add some new classes and can furtherly optimized the model.

Figure 5: Version 1 model confusion matrix



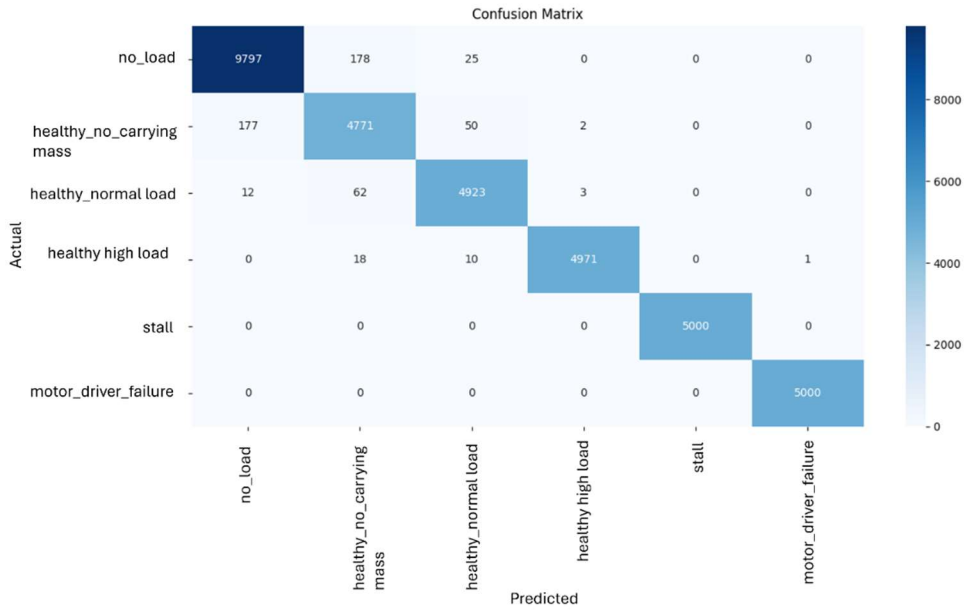
Parameter variations can be identified in Node-RED dashboard, where parameters are displayed in real-time as text and graphs with real-time stamps. These graphs allow for real-time identification of parameter variations showed in the Figure 6.

Figure 6: Node red dashboard chart



For the version two model, healthy class was split to three different classes such as no carrying mass, normal load and high load. Now the model is confused more than version one model because data overlapping. Now there is considerable confusion between no load and healthy no carrying mass classes and there are some other confusions among other classes also showed in the Figure 7.

Figure 7: Version 2 model confusion matrix



In version three model, 8 prediction output classes were defined which is in the Figure 8. The model can identify no load, wheels only, motor driver failure and stall condition as faulty conditions and no carrying mass, low load, medium load and high load as healthy condition. Model was much confused when identifying faulty stall data and healthy high load data. This model was chosen as the final model because it can identify all the possible classes that data was collected. Final accuracy report and cross validation accuracies are in the Figure 9.

Figure 8: Version 3 model confusion matrix

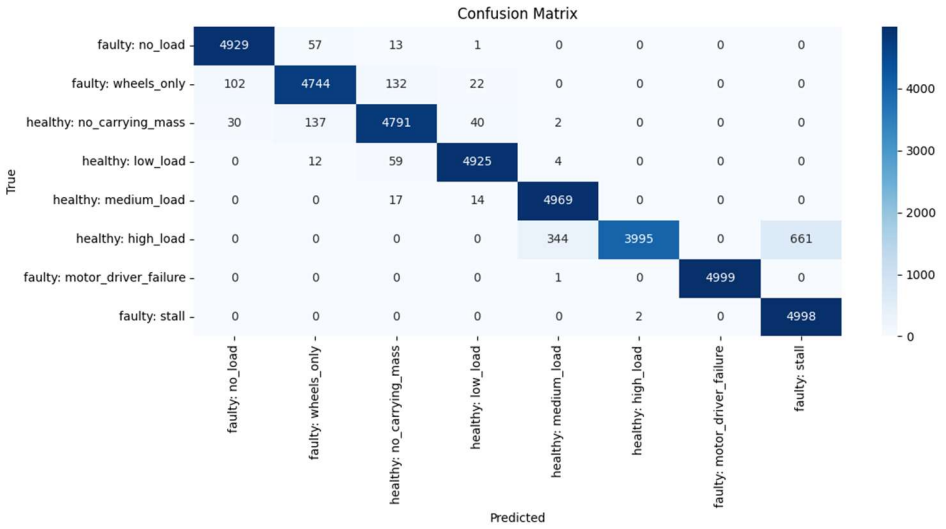


Figure 9: accuracy report and cross validation accuracies of the version three model

	precision	recall	f1-score	support
faulty: no_load	0.97	0.99	0.98	5000
faulty: wheels_only	0.96	0.95	0.95	5000
healthy: no_carrying_mass	0.96	0.96	0.96	5000
healthy: low_load	0.98	0.98	0.98	5000
healthy: medium_load	0.93	0.99	0.96	5000
healthy: high_load	1.00	0.80	0.89	5000
faulty: motor_driver_failure	1.00	1.00	1.00	5000
faulty: stall	0.88	1.00	0.94	5000
accuracy			0.96	40000
macro avg	0.96	0.96	0.96	40000
weighted avg	0.96	0.96	0.96	40000

Cross-validation accuracy scores: [0.935625 0.986625 0.985875 0.98425 0.901375]
Average cross-validation accuracy: 95.88%

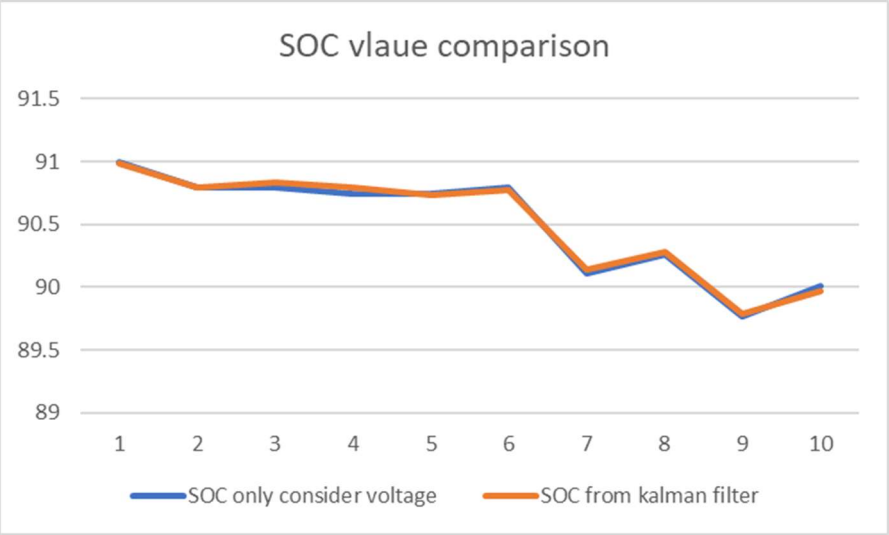
4.2. SOC prediction algorithm results

To validation of the SOC algorithm hardcoded voltage, current and temperature values were used and found SOC of those values using both open circuit voltage method and Kalman filter estimation SOC and compared it. In the open circuit voltage method only

consider voltage and get ratio between difference of measured voltage and cutoff voltage vs difference between full charge voltage and cut-off voltage. But in the Kalman filter current, voltage and temperature behaviour were considered.

From this graph showed in the Figure 10 can identify there no considerable difference in both methods but since Kalman filter is taken into account all current, voltage and temperature values together that methos should be more accurate.

Figure 10: SOC value comparison of both methods



5. *Conclusion*

This research developed and implemented an IoT-based real-time monitoring system for AGVs, leveraging the MQTT protocol, machine learning, and Kalman filter-based prediction models to enhance the detection and diagnosis of powertrain faults. The system monitors battery and motor parameters in real time, demonstrating a significant improvement in fault detection and diagnosis, thereby validating the research hypothesis.

The MQTT protocol was utilized for efficient real-time data transmission, a random forest machine learning approach was applied for motor health prediction, and a Kalman filter was used to estimate the SOC accurately. Results indicated that the system reliably

predicts critical health parameters, such as motor condition and SOC, with high accuracy and speed, enabling proactive fault detection and minimizing AGV downtime. By integrating real-world AGV data, this system provided robust predictive analytics, enhancing operational reliability compared to earlier simulation-based studies.

While the study focused on the battery's discharging profile, future work should extend the analysis to include the charging profile for a comprehensive evaluation of the battery's SOH and life expectancy. The system currently lacks fault-actioning mechanisms, such as emergency stops or power-down features, which could improve safety and reliability. Future enhancements should include these mechanisms, alongside additional environmental sensors to measure parameters like humidity, AGV speed, and inclination. This expanded dataset would further improve the accuracy of fault prediction models and contribute to a safer and more reliable AGV operation in industrial environments.

The study presented here is limited to a small scale AGV with a load limit of 5kg. it is expected that the proposed method can be extended for use of AGVs of larger scales with proper adjustments.

REFERENCES

Dares, M., Goh, K. W., Koh, Y. S., Yeong, C. F., Su, E., & Tan, P. H. (2020). Development of AGV as Test Bed for Fault Detection. International Conference on Control, Automation and Robotics (ICCAR) . IEEE.

E. Adi, A. A. (2020). Machine learning and data analytics for the IoT. Neural Computing and Applications.

Joshi, R., Jadav, H. M., Mali, A., & Kulkarni, S. V. (2016). IOT application for real-time monitor of PLC data using EPICS. International Conference on Internet of Things and Applications (IOTA) . IEEE.

K. Krot, G. I. (2022). Predictive monitoring system for autonomous mobile robots battery management using the industrial internet of things technology. Advanced Material, Machinability & Intelligent Future Manufacturing Systems.

M. Zhong, Y. Y. (2020). Multi-AGV scheduling for conflict-free path planning in automated container terminals. Computers & Industrial Engineering.

Ma, G., Ghasemi, M., & Song, X. (2017). Integrated Powertrain Energy Management and Vehicle Coordination for Multiple Connected Hybrid Electric Vehicles. IEEE Transactions on Vehicular Technology, 2893 - 2899.

P. Shrivastava, T. K. (2019). Overview of model-based online state-of-charge estimation using Kalman filter family for lithium-ion batteries. Renewable and Sustainable Energy Reviews.

Q. Wang, J. J. (2022). State of Charge Estimation of Li-Ion Battery Based on Adaptive Sliding Mode Observer. Sensors.

S. Safavi, M. A. (2021). Multi-Sensor fault detection, identification, isolation and health forecasting for autonomous vehicles. Artificial Intelligence and Internet of Things in Autonomous Vehicles.

Shen, T., Kilic, A., & Reuss, H.-C. (2018). A new system diagnostic method for powertrain of automated electric vehicles. International Conference on Intelligent Transportation. IEEE

Vitabile, S. (2019). Medical Data Processing and Analysis for Remote Health and Activities Monitoring. In S. V. al, High-Performance Modelling and Simulation for Big Data Applications (pp. 186–220). SPRINGER.

Wen-Qiang Zou, Q.-K. P. (2021). An effective multi-objective evolutionary algorithm for solving the AGV scheduling problem with pickup and delivery. Knowledge-Based Systems.

Wolf, I. P. (2020). Health Monitoring System for Autonomous Vehicles using Dynamic Bayesian Networks for Diagnosis and Prognosis. Journal of Intelligent and Robotic Systems.

THE IMPACT OF PUBLIC INVESTMENT ON ECONOMIC GROWTH IN SRI LANKA

HETTIARACHCHI T P

Faculty of Business, *NSBM Green University, Sri Lanka*

tharushi.h@nsbm.ac.lk

Abstract

The existing body of literature accentuates both the positive and negative relationships between public investment and economic growth. As mentioned in Ghani and Din (2006), the absence of such a stable theoretical aspect indicates that the issue is empirical, and comprehensive evaluation is needed regarding the relationship with respect to the given context. This research adopts an econometric model to assess the impact of public investment on Sri Lanka's Gross Domestic Product (GDP), utilizing annual data from 1978 to 2022, after implementing the trade liberalizing policies. Following the framework used by Ghani and Din (2006), private investment and government consumption variables are introduced in this article for a more extensive analysis. Stationarity tests unveil non-stationary variables, prompting the employment of the Vector Error Correction (VEC) model, affirmed by the Johansen cointegration test. The cointegration equation implies that there is a long-term adverse relationship between public investment, private investment, government consumption, and GDP. Short-run coefficients emphasize favorable impacts on GDP from public and private investments, contrasting with an unfavorable influence from government consumption. Causality analyses uncover that public investment lacks Granger causality for GDP, while both private investment and government consumption individually Granger cause GDP. Moreover, their collective effect Granger causes GDP. Impulse response functions and variance decomposition enhance the depth of the findings in the latter part of the analysis. This study is directed to offer a refined understanding of the dynamics shaping Sri Lanka's economy through the interactions of public investment, private investment, and government consumption.

Keywords: Government Consumption, Granger Causality Test, Gross Domestic Product, Johansen Cointegration Test, Private Investment, Public Investment, VECM

1. Introduction

Ivic (2015) has defined economic growth as a constant increment in the volume of production in a country, in other words, an increment in GDP is the main quantitative indicator of production for one year. As stated in Ghani and Din (2006) the role of public investment in determining the economic growth of a country has been highlighted in an expanding body of literature, which includes recent expansions of the neo-classical growth model and theories of endogenous growth. As per their explanation, the studies by Kormendi and Meguire (1985), Romer (1985), Lucas (1988), Grier and Tullock (1989), Barro (1989), Levine and Renelt (1991), Rebelo (1991), Mankiw et al. (1990), Barro and Lee (1993) and Fischer (1993) have significantly contributed to this discussion. However, as they further mentioned in their study, it is required to note that the argument of whether public investment makes a positive impact on economic growth remains questionable.

Certain previous research articles have extensively emphasized the favorable impacts of public investments on economic growth. Particularly, these studies delve into the significance of public investment in critical domains such as transportation, education, and communication. They accentuate that such public investments enhance economic growth through positive externalities for improving private production functions and encouraging private investments (Cashin, 1995; Devarajan et al., 1996; Milbourne et al., 2003; Rabnawaz & Jafar, 2015). However, it is paramount to comprehend a counter perspective demonstrated in certain scholarly articles. These studies uncovered potential drawbacks associated with inefficient public investments, notably highlighting the crowding out of private investments as a result of inefficiencies in public investment projects (Cavallo & Daude, 2008; Ramirez & Nazmi, 2003; Warner, 2014). This dual view in previous research findings emphasizes the nuanced nature of the relationship between public investments and economic growth. Therefore, as elaborated in the study of Ghani and Din (2006), given the lack of a well-established theoretical model to elaborate the relationship between public investment and economic growth, the matter primarily lies with an empirical concern. This study empirically investigates the relationship between public investment on economic growth in Sri Lanka. This study is

directed to identify the long-run relationship, causal relationship and short-run relationship between public investment and economic growth in Sri Lanka.

2. Literature Review

Beginning with a theoretical foundation, Webb (2024) highlights that the Solow-Swan growth model coming under Neo-classical economics, independently developed by Solow (1956) and Swan (1956), continues to serve as a fundamental thought in the theory of economic growth. This model provides a framework for exploring the key drivers of economic growth, with a special focus on capital accumulation, labor growth and technological advancement. As identified in the article of Palley (1996), there are two critical Keynesian influences that are missing in the Neo-classical growth models. First, Keynesian theory suggests that capital accumulation is driven by investment, where the Neo-classical view ties it to household savings behavior. Second, Keynesian theory argues that in equilibrium, output growth is constrained by the growth of aggregate demand. In contrast, Neo-classical theory suggests a dynamic version of Say's law, where demand automatically adjusts to match output growth. And furthermore, Keynesian theory explains the role of investment in economic growth through the increase of aggregate demand. As further stated by Palley (1996), The British approach to endogenous growth emphasizes the role of investment in physical capital. As cited in the article of Palley (1996), building on the studies of Kaldor (1957), Kaldor and Mirrlees (1962) and Scott (1989) argues that investment expenditure drives technological innovation, with technical progress emerging as an endogenous result of capital accumulation. In this view, investment serves three functions: (1) increasing the capital stock, (2) integrating technological innovations into production, and (3) revealing new opportunities for further innovation. In conclusion, the Neo-classical growth theory, Keynesian growth model and the endogenous growth model have emphasized the role of investment in determining the economic growth of a country.

According to the study of Ghani and Din (2006), the exploration into the role of public investment in determining economic growth has been a vital fact in both theoretical and empirical literature. In both strands of research, there is a common understanding that the government’s actions make an important impact on macroeconomic performance.

Empirical studies have applied different approaches to evaluate the relationship between public investments and economic growth. Milbourne et al. (2003) used an extended version of Mankiw, Romer and Weil's augmented Solow– Swan growth model to investigate the role of public investment in determining economic growth by applying the Ordinary Least Square (OLS) method. Their findings revealed that there was a positive conditional correlation between public investment and economic growth; also, they highlighted some evidence in favor of positive contributions from public investments in transportation, education and communication. Devarajan et al., (1996) investigated the relationship between the composition of public expenditure and economic growth and the OLS method has been used in the analysis. They elaborated their findings as change in the mix of public spending could lead to a higher steady-state economic growth. Cashin (1995) studied the relationship among public investment, transfers and taxes, using the endogenous growth model which assumes both public and private capital stock is determined endogenously. He concluded his study by summarizing the empirical results as increasing government spending which motivates private production function enhances economic growth. He directly stated that for instance public investment generates positive externalities which cause to increase private investments and economic growth. Rabnawaz and Jafar (2015) have conducted research on the impact of public investment on economic growth in Pakistan using the autoregressive model and independent variables including government revenue, public investments, real interest rate and two lags of GDP. As per their conclusion, there is a positive relationship between public investment and GDP in the short run, in other words, one-rupee increase in public investment will push up the value of GDP. Further, their empirical results have stated that the increase in GDP causes a rapid increase in public investments.

While asserting certain literature that emphasizes the favorable impacts of public investment on economic growth, it's vital to acknowledge the research findings expressing a conflicting perspective discussing the inefficiency of public investment. Cavallo and Daude (2008) analyzed the linkage between public investment, private investment and economic growth using panel data from 116 developing countries during 1980 to 2006 by applying GMM system estimators which is used for dynamic panel data analysis. They mainly highlighted some points regarding public investments; it

should be focused on increasing productivity competitiveness, project selection is very much critical in infrastructure projects, it is necessary to have adequate planning, cost benefit analysis, and ongoing monitoring and evaluation. As a conclusion they noted that if public investment were either nonproductive or there were distortions associated with the public investment process, there would tend to crowd out private investments by public investments. Ramirez and Nazmi (2003) have empirically investigated the relationship between public investment and economic growth in Latin America by using a modified neoclassical growth model and its production function. As per their obtained results from the panel data analysis, both public and private investments contribute to the economic growth of a country. As per their investigation, public investment spending tends to crowd out private investments and they explained a reason for this as spending on infrastructure makes a positive impact on private investment, while investing inefficient state-owned organizations trends to crowd out private investments. Warner (2014) has empirically studied whether big infrastructure and public capital drives have succeeded in accelerating economic growth in low-income countries using a panel data set consists of 124 middle- and low-income countries. When considering the empirical results, it is observable that there is a weak positive association between investment spending and growth on average and only in the same year, as lagged impacts are not significant. In simple terms, as per their conclusion there is a very small impact of public investments on the short run economic growth. With the absence of a clear theoretical relationship between public investment and economic growth, this study is conducted to explore this relationship empirically in the context of Sri Lanka.

According to Ghani and Din (2006), many empirical studies have applied the Vector Autoregressive (VAR) model to explore the relationship between public investment and economic growth, and they have adopted the same analytical approach. In addition to that, in the justification Ghani and Din (2006) have mentioned some previous studies, for instance, Naqvi (2002) investigated the correlation between public investment and economic growth by using the VAR model. As further mentioned in the same research article, Mittnik and Neumann (2001) have employed the VAR model to identify a positive relationship between public investment and GDP across six industrial countries. Significantly, Ghani and Din (2006) emphasized an advantage of using VAR models, which is the absence of a priori causality directions or the requirement for identifying

conditions from economic theory, then allowing for the consideration of indirect impacts of public investment. Therefore, this study uses the VAR model for the empirical study of the relationship between public investment and economic growth.

In conclusion of the literature review, it was found that the current body of research demonstrates both positive and negative relationships between public investment and economic growth. As noted by Ghani and Din (2006), the lack of a consistent theoretical framework shows that the relationship is largely empirical, emphasizing the requirement of a comprehensive evaluation within specific contexts. Specifically, in the case of Sri Lanka, there is a notable gap in literature investigating this phenomenon. Therefore, this research aims to examine the impact of public investment on economic growth in Sri Lanka, drawing on the model proposed in the study by Ghani and Din (2006).

3. Methodology

This research adopts a research paradigm based on Ontology, particularly the philosophy of Realism, which explains that reality exists independently of human thoughts, beliefs, or knowledge of its existence (Saunders et al., 2009). The research approach taken is deductive in nature, aligning with theory-testing research, where hypotheses derived from existing theories are tested against empirical data (Saunders et al., 2009). Since this study is directed to establish causal relationships between variables, this study can be classified as explanatory research, focusing on understanding how and why certain phenomena occur (Saunders et al., 2009). The research choice is mono-method, utilizing secondary data for quantitative analysis. Furthermore, the time horizon of the study is based on time-series data. As the data analysis techniques, VAR model is used and properly justified the selection in the upcoming section.

As outlined by Ghani and Din (2006), the VAR model has been employed the VAR model to explore the relationship between public investment and economic growth, and this method was selected for two reasons. As cited in Ghani and Din (2006), the first reason is avoiding any predefined constraints on the selected variables, encompassing the forward-looking nature of investments. Secondly, this approach facilitates the exploration of both the long-run and short-run relationship between public investment and economic growth within a cointegration framework (Johansen, 1988cited in Ghani

and Din, 2006). This study uses the same variables used by Ghani and Din (2006), public investments (GI), government consumption (GC) and private investments (PI), and gross domestic product (GDP), and data have been collected from the annual reports of the Central Bank in Sri Lanka from 1978 to 2022. In order to simplify the analysis and avoid large numbers from the dataset, the logarithm of all variables has been applied. As described in Ghani and Din (2006), both public and private investments can be recognized as significant determinants of economic growth, which contribute to the physical capital formation in an economy. As they shown, the breakdown of investment into two; public investment and private investment, not only allows for assessing their impacts on economic growth, but it also facilitates the identification of insights into whether public investment displaces private investment. Further as cited in Ghani and Din (2006), this topic has been comprehensively discussed in the previous literature. Additionally, following the above study by Ghani and Din (2006) public consumption is included as a variable in the analysis, since it is considered as a factor that can either support or hinder economic growth based on the nature of such spending.

The analysis commences with the unit root test to check the stationarity, employing both the Augmented Dickey Fuller (ADF) test and Phillips-Perron (PP) test. If the dataset is identified as stationary, the Vector Autoregressive (VAR) model is employed directly. Conversely, in the case of non-stationary data with cointegration relationships, the Vector Error Correction (VEC) model is adopted. Consequently, the Granger Causality Test is applied to evaluate causal relationships, while the impulse response function and variance decomposition are utilized to identify the dynamic response path of the variables under consideration. The analysis of the study is conducted by using the EViews Version 12.

4. Data Analysis

4.1 Stationary Analysis

The commonly used unit root tests namely, ADF and PP tests have been employed to assess the stationarity of *lgdp (logarithm of GDP), lgi (logarithm of government/ public investment, lpi (logarithm of private investment) and lgc (logarithm of government consumption)*. According to the test results presented in Table 1, *lgdp, lgi, lpi and lgc* variables are not stationary at levels. As per the test results in Table 2, *lgdp, lgi, lpi and*

lgc variables are stationary at the first difference based on results obtained from both ADF and PP tests.

Table 1: Unit Root Test Results at Levels

Source: Author generated

Variable	ADF Level	PP Level
lgdp	-1.114716	-1.814937
lgi	-0.893314	-0.893314
lpi	-1.333769	-1.306754
lgc	-1.562753	-1.663316

Table 2: Unit Root Test Results at First Difference

Source: Author generated

Variable	ADF Level	PP Level
lgdp	-4.420333*	-3.144645*
lgi	-4.142637*	-7.344103*
lpi	-5.897431*	-8.221478*
lgc	-6.644835*	-6.644835*

4.2 Estimation of the VAR Model

The first concern in the VAR model is determining the lag structure for this analysis in other words, establishing the optimal number of lag intervals. There are several methods, which can be applied to ascertain the optimal number of lag intervals. Particularly in this research, both the Lag Length Criteria and AR Roots Graph methods are applied to establish the most suitable lag length. As outlined in Table 3, based on Akaike Information Criteria (AIC), Final Prediction Error (FPE), and sequential modified LR test statistic (LR) it is observed that the optimal lag order for this VAR model is 02.

Table 3: Log Length Criteria

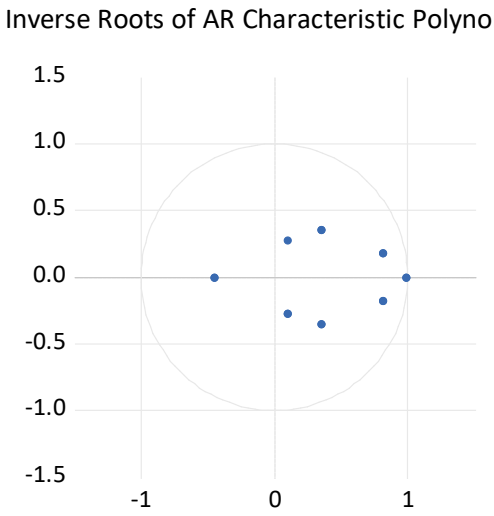
Source: Author generated

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-53.04196	NA	0.000178	2.716284	2.881776	2.776943
1	143.3133	345.9592	3.33e-08	-5.872060	-5.044599*	-5.568763*
2	160.6263	27.20617*	3.19e-08*	-5.934585*	-4.445154	-5.388650
3	172.3360	16.17056	4.15e-08	-5.730286	-3.578886	-4.941713

Subsequently, the VAR model is revised with 02 lags, and an AR root graph is obtained as given in Figure 1. It illustrates that the reciprocal of each characteristic root inside the circle, indicating that a lag length of 02 is appropriate, and the given VAR model is stable after enduring a stability test.

Figure 1: AR Root Graph

Source: Author generated



4.3 Cointegration Test

The Johansen cointegration test is used to investigate the presence of cointegration relationships since the dataset exhibits non-stationarity at levels. The main purpose of this test is to ascertain the rank of these cointegration relationships.

Table 4: Unrestricted Cointegration Rank Test (Trace)

Source: Author generated

Hypothesized No. of CE (s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob. **
None *	0.513104	57.94143	47.85613	0.0043
At most 1	0.347238	27.71381	29.79707	0.0854
At most 2	0.177711	9.799005	15.49471	0.2965
At most 3	0.036946	1.581137	3.841465	0.2086

As presented in Table 4 and Table 5 both the Trace and Maximum Eigenvalue tests reject the null hypothesis which posits that there is no cointegration relationship

between given variables at a 5% significance level. Further, according to these tests it is evident that there is only one cointegration relationship in the model and a Vector Error Correction (VEC) model can be further adopted for this study.

Table 5: Unrestricted Cointegration Rank Test (Maximum Eigen Value)

Source: Author generated

Hypothesized No. of CE (s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob. **
None *	0.513104	30.22762	27.58434	0.0224
At most 1	0.347238	17.91481	21.13162	0.1331
At most 2	0.177711	8.217868	14.26460	0.3570
At most 3	0.036946	1.581137	3.841465	0.2086

4.4 Estimation of VEC Model

Since the obtained optimal lag structure for the VAR model is 02, the optimum number of lags for the VEC model should be 01, and number of cointegration relationships should be 01. Table 6 shows the estimates of the VEC model and based on the output cointegration equation is derived in Equation 1.

$$lgdp_{t-1} = -0.116560 lgi_{t-1} - 0.169792 lpi_{t-1} - 0.697073 lgc_{t-1} - 2.470787 \quad [1]$$

As Equation 1 expresses, when other things remain constant, each percentage point increase in public investment will cause to decrease of 0.116560 percentage points in gross domestic product, and each percentage point increase in private investment will cause to decrease of 0.169792 percentage points in gross domestic product. Furthermore, each percentage point increase in government consumption will cause to decrease of 0.169792 percentage points in gross domestic product. However, considering the statistical significance of these coefficients, only the coefficient of government consumption variable is statistically significant at 5% significance level.

Table 6: Vector Error Correction Estimates (Cointegration Equation)

Source: Author generated

Variable	ADF Level
LGDP(-1)	1.000000
LGI(-1)	-0.116560 (-1.41516)
LPI(-1)	-0.169792 (-1.68345)
LGC(-1)	-0.697073 (-7.31500)

In addition to the cointegration equation, error correction terms, in other words speed of adjustments $(1-\theta)$ can be identified from VEC estimations in Table 6. Moreover, based on the estimated results of VEC model, Equation 2 has been estimated in order to calculate the short-run and long run coefficients. The estimation results are given in Table 7.

$$D(LGDP) = C(1) * (LGDP(-1) - 0.116560200479 * LGI(-1) - 0.169791822764 * LPI(-1) - 0.697072529616 * LGC(-1) - 2.4707867638) + C(2) * D(LGDP(-1)) + C(3) * D(LGI(-1)) + C(4) * D(LPI(-1)) + C(5) * D(LGC(-1)) + C(6) \quad [2]$$

Error Correction:	**D(LGDP)**	**D(LGI)**	**D(LPI)**	**D(LGC)**
CointEq1	-0.129323	-0.267147	0.004481	0.523663
	(-1.81618)	(-1.05596)	(0.02418)	(3.02740)
D(LGDP(-1))	0.256624	-0.052850	0.285149	0.459741
	(1.40702)	(-0.08156)	(0.60068)	(1.03766)
D(LGI(-1))	0.032252	-0.284780	0.077972	0.304512
	(0.63628)	(-1.58132)	(0.59102)	(2.47306)
D(LPI(-1))	0.137845	0.203271	0.114046	0.122358
	(1.96486)	(0.81551)	(0.62458)	(0.71797)
D(LGC(-1))	-0.123783	0.169759	-0.306844	0.010564
	(-1.98308)	(0.76547)	(-1.88872)	(0.06967)
C	0.097796	0.110611	0.129239	0.015086
	(4.18280)	(1.33156)	(2.12378)	(0.26562)

The long run coefficient C(1) is negative and marginally significant at 10% significance level which shows long run causality between *lgi,lpi and lgc* to *lgdp*. This coefficient should have a negative sign showing the ability to bounce back to equilibrium. Short-run coefficient C (2) indicates that a percentage increase in itself (GDP) will lead to an increase of 0.256624 percentage points in GDP. Short-run coefficient C (3) indicates that a percentage increase in public investment will lead to an increase of 0.032252 percentage points in GDP. Short-run coefficient C (4) indicates that a percentage increase in private investment will lead to an increase of 0.137845 percentage points in GDP. Short run coefficient C (5) indicates that a percentage increase in government consumption will lead to a decline of 0.123783 percentage points in GDP. Considering this model estimations, the probability of F-statistic is significant, indicating that the overall model is significant. The Durbin-Watson statistic is within the range of 1.5 and

2.5, which shows that there is no serial correlation in the model. Other than that, the results of diagnostic tests will be discussed in the next section.

Table 7: Estimation of Short-run and Long-run Coefficients

Source: Author generated

		Coefficient	
C(1)		-0.129323 (-1.816179)	
C(2)		0.256624 (1.407024)	
C(3)		0.032252 (0.636276)	
C(4)		0.137845 (1.964858)	
C(5)		-0.123783 (-1.983084)	
C(6)		0.097796 (4.182803)	
R-squared	*0.342747*	*Adj.R-squared*	*0.253929*
F- statistic	*3.858988*	*Prob(F-statistic)*	*0.006492*
Durbin-Watson stat	*1.5459*		

(*Note: t-statistics are in parentheses)*

4.5 Diagnostic Tests

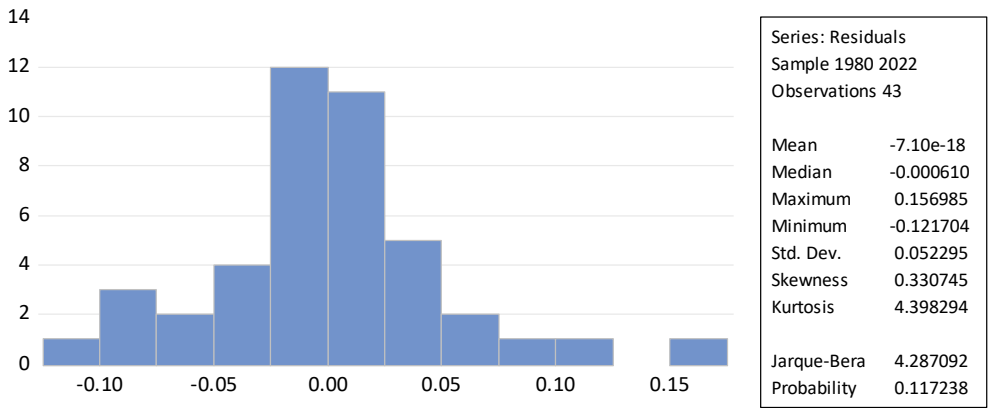
4.5.1 Normality Test

H_0: The dataset is normal.

Here the normality is tested by using the Jarque-Bera test, which has a test value of 4.287092 and significance value of 0.117238. Therefore, the null hypothesis is not rejected at 5% significance level (Figure 2) The normality assumption is there.

Figure 2: Normality Test

Source: Author generated



4.5.2 Test for Serial Correlation

H_0: There is no serial correlation up to 02 lags.

Here, the serial correlation is tested by adopting the Breusch-Godfrey Serial Correlation LM test, which has an Observed R-squared value of 3.196753 with Prob. Chi-Square (2) value of 0.2022. Therefore, the null hypothesis is not rejected at 5% significance level, which states that there is no serial correlation.

4.5.3 Test for Heteroscedasticity

H_0: Homoscedasticity

Here, the heteroscedasticity is tested by employing Breusch-Pagan-Godfrey test, which has an Observed R-squared value of 8.696108 with Prob. Chi-Square(2) value of 0.3686. Therefore, the null hypothesis is not rejected at 5% significance level, which states that there is no issue of heteroscedasticity.

4.6 Granger Causality Test

The Johansen cointegration test reveals the existence of long-term relationship between the given variables. However, to identify a causal relationship between them, additional testing is necessary which is called Granger Causality Test. If variable A is useful in the prediction of variable B, particularly that previous values of A, alongside previous values of B, are included in the regression of B, this combination can improve the explanatory power of the regression. If A is considered as a precursor to changes in B, it is known as a Granger cause of B; otherwise, it is identified as a non-Granger cause. The respective p-value is less than 0.05, supporting the acceptance of the null hypothesis regarding the existence of a Granger cause. The Granger Causality Test results are given in Table 8.

H_0: The given variable does not Granger cause the dependent variable.

In this case, the lgdp is the dependent variable. As per the test results, lgi does not Granger cause lgdp, lpi Granger causes lgdp, and lgc Granger causes lgdp. In addition to that, the combined effect of lgi, lpi and lgc Granger causes lgdp.

Table 8: Granger Causality Test Results

Source: Author generated

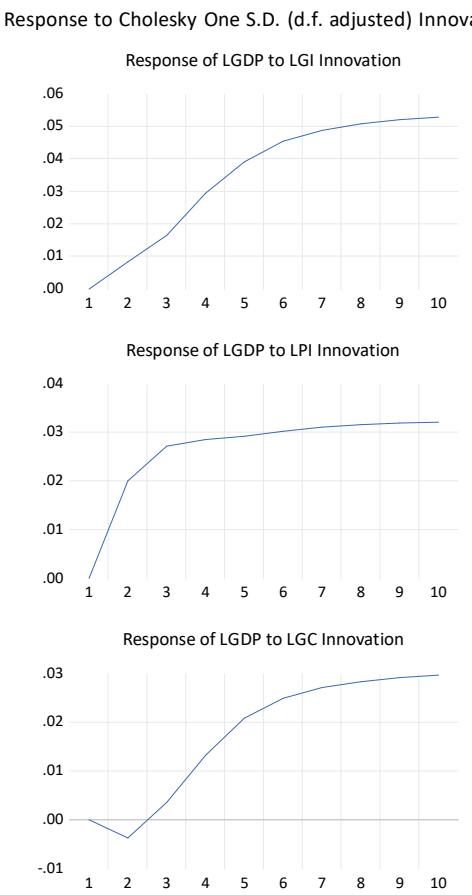
Excluded	Chi-sq	df	Prob.
D(LGI)	0.404848	1	0.5246
D(LPI)	3.860669	1	0.0494*
D(LGC)	3.932621	1	0.0474*
All	8.626423	3	0.0347*

4.7 Impulse Response Function

To delve more into how the GDP responds to shocks of other variables (public investment, private investment and government consumption), further scrutiny is undertaken through the application of VECM-based impulse response functions and variance decomposition. The results of this analysis are derived for a duration of ten time periods (Figure 3).

Figure 3: Impulse Response Graphs

Source: Author generated



Response of lgdp to lgi: When there is a shock in lgi, lgdp will not show any changes in the first period and will gradually increase up to the fifth time period at an increasing rate, then it will start to increase at a decreasing rate up to the tenth time period.

Response of lgdp to lpi: When there is a shock of lpi, lgdp will not show any changes in the first period and will show a drastic increase in the second period, then it will show a gradual increment from the third period to the tenth period.

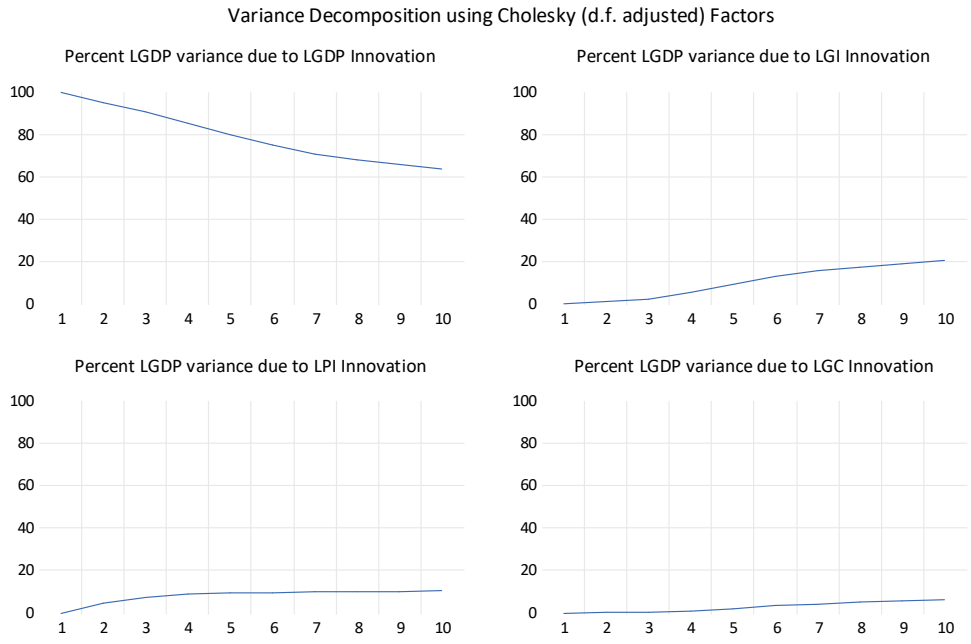
Response of lgdp to lgc: When there is shock of lgc, lgdp will not show any changes in the first period, decline in the second period and it will show a gradual increment from the third period to the tenth period.

4.8 Variance Decomposition

The impulse response function renders how a system's shock makes an impact on an internal variable, while variance decomposition entails a breaking down of the mean square error into the individual contributions of each variable, variance decomposition assists the analysis of how changes in each variable influence the other variables, unveiling their relative effects.

Figure 4: Variance Decomposition Graphs

Source: Author generated



As illustrated in Figure 4, in *lgdp* predicted variance, contribution of *lgdp* declines gradually from the first period, reaches around 63.59% in the tenth period and shows a declining trend. *lgi* contributions increases from 0.00% to 20.18% by the end of the 10th period. Considering the contribution of *lpi* and *lgc* contributions increase from 0.00% to 10.27% and 5.95% respectively by the end of the tenth period.

As an overview, the cointegration equation, indicative of a long-term relationship, outlines an inverse relationship between public investment and GDP, as well as private investment and GDP, along with government consumption and GDP in the Sri Lankan context. Considering the short-run coefficients, they reveal that there is a positive impact on GDP from both public and private investments, while government consumption shows a negative impact on GDP. Regarding causality, public investment does not Granger cause GDP individually. However, both private investment and government consumption Granger cause GDP individually. Moreover, the combined effect of public investment, private investment, and government consumption Granger causes GDP.

5. Discussion

As stated in the study of Ghani and Din (2006), one perspective in the literature suggests that public investment stimulates private sector productivity, thereby fostering economic growth. Conversely, other studies highlight the issues in the efficiency of public investment, suggesting it may not always positively make an impact on economic growth. Further it states that empirical research has generally provided inconclusive results regarding the relationship between public investment and economic growth. In this study, in the short run, public investment has a positive impact on GDP, stimulating private sector productivity, but only temporarily, because public investment exhibits a negative relationship with GDP in the long run, raising concerns about the efficiency of public investments in Sri Lanka. Previous studies by Cavallo and Daude (2008), Ramirez and Nazmi (2003), and Warner (2014) has highlighted the inefficiency or lack of productivity in public investment. These studies suggest that if public investment is unproductive or if there are distortions in the public investment process, it could crowd out private investments. They further argue that for public investment to be effective, it should focus on enhancing productivity and competitiveness. Additionally, careful

project selection is critical, specifically for infrastructure projects, which require adequate planning, cost-benefit analysis, and ongoing monitoring and evaluation. To improve the efficiency of public investment, Sri Lanka should adopt these practices and focus on ensuring that public investments are both productive and well-managed.

6. Conclusion

In conclusion, this research has adopted an econometric model to scrutinize the influence of public investment on GDP in Sri Lanka, using annual data spanning from 1978 to 2022. Establishing the framework employed by Ghani and Din (2006), this model incorporated two additional variables, private investment, and government consumption into the analysis. The initial stage involved subjecting the dataset to stationarity tests, uncovering the non-stationary nature of the variables. Subsequently, the Johansen cointegration test revealed the presence of a cointegration relationship, allowing the adoption of the Vector Error Correction (VEC) model for comprehensive analysis. The cointegration equation, manifesting a long-term relationship, emphasized a negative relationship between public investment and GDP, as well as private investment and GDP, along with government consumption and GDP. Aligning with previous literature findings, empirical evidence backs the notion of a negative association between public investment and economic growth, attributing it to the potential crowding-out effect on private investments. For further analysis, it is recommended to evaluate whether public investment in Sri Lanka promotes or hinders private investment, drawing insights from studies conducted by Mitra (2006) and Nguyen and Trinh (2018). The short-run coefficients represent a positive impact on GDP from both public and private investments, while government consumption exerts a negative impact on GDP.

Exploring causality, public investment alone does not Granger cause GDP and conversely, both private investment and government consumption individually Granger cause GDP. Moreover, the joint effect of public investment, private investment, and government consumption collectively Granger causes GDP.

In the latter part of the analysis, the utilization of impulse response functions and variance decomposition has improved the robustness of our findings. To augment the

significance of the obtained results, it is suggested to expand the dataset by extending the time horizon or increasing the frequency, such as employing quarterly or monthly data. This expansion would contribute to a more comprehensive evaluation of the dynamics between public investment, private investment, and government consumption in shaping Sri Lanka's economy.

REFERENCES

Barro, R. (1989). Economic growth in a cross section of countries (NBER Working Paper Series No. 3120). https://www.unhcr.org/publications/manuals/4d9352319/unhcr-protection-training-manual-european-border-entry-officials-2-legal.html?query=excom 1989

Barro, R. J., & Lee, J.-W. (1993). International data on educational attainment (NBER Working Paper Series No. 4349).

Cashin, P. (1995). Government spending, taxes, and economic growth. Staff Papers (International Monetary Fund), 42(2), 237–269.

Cavallo, E., & Daude, C. (2008). Public investment in developing countries: A blessing or a curse? (Research Department Working Papers No. 648). https://doi.org/10.1016/j.jce.2010.10.001

Devarajan, S., Swaroop, V., & Zou, H.-F. (1996). The composition of public expenditure and economic growth. Journal of Monetary Economics, 37(2), 313–344. https://doi.org/10.1016/S0304-3932(96)90039-2

Fischer, S. (1993). The role of macroeconomic factors in growth (NBER Working Paper Series No. 4565).

Ghani, E., & Din, M. (2006). The impact of public investment on economic growth in Pakistan. The Pakistan Development Review, 45(1), 87–98.

Grier, K. B., & Tullock, G. (1989). An empirical analysis of cross-national economic growth. Journal of Monetary Economics, 24, 259–276.

Ivic, M. M. (2015). Economic growth and development. Journal of Process Management – New Technologies, 3(1). https://doi.org/10.4324/9780429042546-6

Johansen, S. (1988). Statistical analysis of cointegration vectors. Journal of Economic Dynamics and Control, 12, 231–254.

Kaldor, N. (1957). A model of economic growth. The Economic Journal, 67(268), 591–624.

Kaldor, N., & Mirrlees, J. A. (1962). A new model of economic growth. Review of Economic Studies, xxix, 174–192.

Kormendi, R. C., & Meguire, P. G. (1985). Macroeconomic determinants of growth: cross-country evidence. Journal of Monetary Economics, 16(2), 141–163. https://doi.org/10.1016/0304-3932(85)90027-3

Levine, R., & Renelt, D. (1991). Cross-country studies of growth and policy (The PRE-Working Paper Series No. WPS 608).

Lucas, R. E. (1988). On the mechanics of economic development. Journal of Monetary Economics, 22, 3–42.

Mankiw, N. G., Romer, D., & Weil, D. N. (1990). A contribution to the empirics of economic growth (NBER Working Paper Series No. 3541). https://doi.org/10.4324/9781315064079-8

Milbourne, R., Otto, G., & Voss, G. (2003). Public investment and economic growth. Applied Economics, 35(5), 527–540. https://doi.org/10.1080/0003684022000015883

Mitra, P. (2006). Has government investment crowded out private investment in India? The American Economic Review, 96(2), 337–341.

Mittnik, S., & Neumann, T. (2001). Dynamic effects of public investment: Vector autoregressive evidence from six industrialized countries. Empirical Economics, 26, 429–446. https://doi.org/10.1007/s001810000064

Naqvi, N. H. (2002). Crowding-in or crowding-out? Modelling the relationship between public and private fixed capital formation using co-integration analysis: The case of Pakistan 1964-2000. Pakistan Development Review, 41(3), 255–276. https://doi.org/10.30541/v41i3pp.255-276

Nguyen, C. T., & Trinh, L. T. (2018). The impacts of public investment on private investment and economic growth: Evidence from Vietnam. Journal of Asian Business and Economic Studies, 25(1), 15–32. https://doi.org/10.1108/JABES-04-2018-0003

Palley, T. I. (1996). Growth theory in a Keynesian mode: Some Keynesian foundations for new endogenous growth theory. Journal of Post Keynesian Economics, 19(1), 113–135. https://doi.org/10.1080/01603477.1996.11490100

Rabnawaz, A., & Jafar, R. M. S. (2015). Impact of public investment on economic growth. South Asia Journal of Multidisciplinary Studies, 1(8), 62–75.

Ramirez, M. D., & Nazmi, N. (2003). Public investment and economic growth in Latin America: An empirical test. Review of Development Economics, 7(1), 115–126.

Rebelo, S. (1991). Long-run policy analysis and long-run growth. Journal of Political Economy, 99, 500–521.

Romer, P. (1985). Increasing returns and long run growth (Rochester Center for Economic Research Working Papers No. 27). http://rcer.econ.rochester.edu/RCERPAPERS/rcer_27.pdf

Saunders, M., Lewis, P., & Thornhill, A. (2009). Research methods for business students (Fifth). Pearson Education. https://is.vsfs.cz/el/6410/leto2014/BA_BSeBM/um/Research_Methods_for_Business_Students__5th_Edition.pdf

Scott, M. F. (1989). A new view of economic growth. Oxford: Clarendon Press.

Solow, R. M. (1956). A contribution to the theory of economic growth. The Quarterly Journal of Economics, 70(1), 65–94.

Swan, T. W. (1956). Economic growth and capital accumulation. Economic Record, 32(2), 334–361.

Warner, A. (2014). Public investment as an engine of growth (IMF Working Papers No. WP/14/148).

Webb, A. (2024). Revisiting the Solow growth model a theoretical examination of technological progress in developing economies. International Journal of Management Research and Economics, 4(2), 18–24. https://doi.org/10.51483/ijmre.4.2.2024.18-24

FACTORS INFLUENCING THE PERCEPTION OF TAX EVASION: A CASE STUDY OF UNDERGRADUATES IN PRIVATE UNIVERSITY

DISSANAYAKA T N, WEERASINGHE D D G R

Department of Accounting & Finance,

Faculty of Business, NSBM Green University, Sri Lanka

tharushadissanayaka47@gmail.com, gayani.w@nsbm.ac.lk

Abstract

This quantitative study looks into the views of tax evasion among undergraduate students. The factors associated with tax evasion were deemed to be institutional, economic, socio-psychological, political, and legal aspects. This study examined 375 undergraduate students at the NSBM Green University using a 5-point Likert scale to identify the factor that influences tax evasion the most. The questionnaire was used to collect the survey responses. The results show that socio-psychology, political & legal, and economic factors have a moderate relationship with the perception of tax evasion while institutional factors have a strong relationship with the perception of tax evasion. The results demonstrate that economic factors like tax rates, penalties, audits, and taxpayer privileges, as well as socio-psychological ones like moral obligation, social influences, and the fairness of the tax system, all have an impact on tax evasion. The findings demonstrate that socio-psychosocial factors and institutional factors are thought to be a highly significant driver that influences individual income tax evasion in the Sri Lankan setting. Income tax evasion in Sri Lanka is said to be greatly influenced by institutional and sociopsychological factors in this regard because of the interaction between system inadequacies and cultural attitudes. It is commonly anticipated that weak institutional frameworks such as perceived corruption, a lack of transparency and insufficient enforcement of tax laws—will reduce public confidence in the tax system. Furthermore, the study offers an understanding of how undergraduate students' gender affects their tax evasion behavior. The findings indicate that tax evasion behaviors by undergraduate students as potential taxpayers may be modified if tax policy decisions give greater consideration to the psychological well-being and financial capacity of taxpayers. Increasing tax compliance can be achieved by distributing the tax burden across more taxpayers.

Keywords: Perception of Tax Evasion, Institutional Political & Legal, Economic, Sociopsychological

1 Introduction

The deliberate payment of less tax than required by law is known as tax evasion. (Elffers and Hessing, 1997). Research demonstrated that elements related to the tax evasion problem had an impact on opinions of tax morality. Likewise, noted that individuals who believe no matter the circumstance, people who view evasion of taxes as a moral issue are more unlikely to do so than those who do not. In a similar vein, Chan and Mo (2000) provided evidence that people conform to tax regulations due to their felt moral obligations to do so. According to Karlinsky, Burton, and Blanthorne (2004), taxpayers may not be scared to evade taxes in an environment where tax evasion is perceived as a minor offence. Crucially, the majority of research on tax evasion ignored philosophical and theoretical viewpoints in favor of economic and public finance ones (McGee, 2005). According to McGee and Lingle (2005), this is most likely due to the fact that most attorneys are legalists and most economists are utilitarians. Tax collection efficiency is increased by the Directorate General of Taxation (DGT). There is a difference of opinion between DGT and taxpayers about this concept, nevertheless, as taxpayers frequently assert that taxes are a burden on them. Even as taxpayers evade paying taxes, DGT consistently maximizes tax sector revenue. (Carolina, n.d.) The Self-Assessment System's execution is where tax avoidance is most noticeable. Taxpayers are provided with trust from DGT in this system to compute, pay, and report their tax payments. The accountability of taxpayers increased as a result, indicating that they were more conscious of their need to pay taxes. In this sense, the efficiency of collecting taxes in this nation is significantly influenced by tax compliance. According to Loo et al. (2009), the most significant factor influencing a taxpayer's compliance behavior is their tax knowledge. Additionally, they demonstrated that the launch of self-assessment had a significant influence on its contribution in the direction of raising tax literacy, since tax literacy overall may influence how taxpayers see taxes. The difference in tax compliance behavior between respondents with and without tax knowledge is explained by another research finding (Roshidi et al., 2007; Kasipillai et al., 2003; Palil, 2005; Carolina & Simanjuntak, 2011). After receiving the taxation studies for one semester, respondents' personal tax compliance will rise. Following those studies, there was a decline in tax evasion as tax awareness rose, hence fostering voluntary tax compliance. Taxes play a crucial role in the operation of any current society and act as the lifeblood

of government transactions and crucial government transactions in general. The government levies taxes to fund social programs such as public safety, education, health care, and infrastructure. As a result, taxes have a significant socioeconomic impact. Through these services, governments may establish a stable economic environment that promotes the growth of enterprises and the welfare of individuals. They are significant in many areas of society and economic development. Taxes can be used to redistribute money, alter economic behavior, and address social issues. There are numerous forms of taxes in place, such as import, consumption, earning, land, transaction, and corporation taxes.

2. Literature Review

Tax evasion is defined as when qualified taxpayers willfully disregard their tax duties, which can seriously impair the overall amount of tax income lost, interfere with the public sector's ability to operate effectively, and jeopardize its ability to pay for essential expenses (Amjath, 2015).

According to an economic perspective, the factors that determine the tax base such as revenue, sales, revenues, assets, and so forth—are frequently not "observable," which is where evasion issues start. According to Luigi Alberto Franzini (1998), when it comes to cash transfers and transactions involving criminal activity, an external observer typically cannot see the entire size of an individual's tax base and, therefore, cannot know their tax due. Although the concept of taxation contends that tax collection costs should be kept to a minimum, this knowledge can occasionally be acquired through expensive audits, in which case it can be validated at a cost. Allingham and Sandmo (1972) are credited with the current use of economic tools for the examination of tax compliance, despite the fact that several theoretical and empirical studies have been conducted to date. The attitude of taxpayers towards tax compliance can be explained in relation to an individual's tax compliance attitude. Many factors can affect tax compliance, including the character of public institutions, the impression of tax justice, the state of the economy, and the likelihood that disobedience will be discovered and penalized. An outside observer cannot clearly see the true extent of each person's taxation and evasion from an economic perspective. When taxpayers engage in cash payments, domestic transactions, or illegal activity, it is difficult to identify them. The

fact that there is no one source of data that can capture all of the information makes studying tax evasion inherently challenging. Stratified random audits have been the main source utilized thus far in wealthy nations. These audits are an effective means of identifying underreported self-employment income, tax credit abuses, and, more generally, any kind of tax evasion that is comparatively simple (Alstadsæter et al., 2019).

Regarding the primary ethical perspectives on avoiding taxes, there are in fact three basic perspectives: (1) tax evasion is rarely morally acceptable, (2) tax evasion is occasionally acceptable, and (3) tax evasion continues to be morally acceptable. The poorest of the three is the first opinion, which holds that taxes are never morally acceptable (McGee, 2006; Drogalas et al. 2018). A person's belief in the equity of the tax structure and "the ability to pay principle" are important elements influencing compliance, according to the moral imperative to pay just taxes. Tax evasion might lessen injustice in situations when tax regulations are deemed unjust, according to Posner (1998). Bastiat (1968) described a just society as one in which injustice does not exist, and this conclusion was predicated on his definition. In order to explain cultural variations in the results of studies carried out globally, it is essential to comprehend the degree to which ethical quandaries and circumstances influence a person's view of the morality of tax evasion (Alm & Torgler, 2011). Over the years, a large number of research have been carried out on different facets of tax and tax evasion (McGee, 2012). Several researchers have reviewed and commented on such findings in the past few years (e.g., Collymore, 2020; Frecknall-Hughes, 2020; van Brederode, 2020). Therefore, there's no need to repeat what has already been done. According to other research, older adults are more opposed to tax evasion than younger ones, possibly as a result of their general respect for the law and authority (Aitken & Bonneville, 1980; Gottfredson & Hirschi, 1990; Hirschi & Gottfredson, 2000; Torgler, 2012; Torgler & Valev, 2010). Nevertheless, not every study has discovered this connection to be accurate (Pardisi & McGee, 2023).

A third stream of research failed to find a relationship between age and attitude toward tax evasion (Hotaling & Arnold, 1981; Jackson & Milliron, 1986; McGee, 2012; Spicer, 1974), while a fourth stream of research found a curvilinear relationship between age and attitude towards tax evasion (Clotfelter, 1983; Song & Yarbrough, 1978). Another

study found that young people are more opposed to tax evasion than older people (McGee, 2012; Wallschutzky, 1984). Numerous research on the subject of gender disparities in tax evasion has found that women obey tax regulations more often than men (Alm, Jackson, & McGee, 2011; Swamy, Knack, Lee, & Azfar, 2001). This was confirmed by an empirical investigation conducted across 82 nations (McGee, 2012). Three categories were used to group the results. Such research revealed that:

1. Women reject tax evasion far more than men do.
2. Male and female opinions on the morality of tax evasion are not considerably different.
3. The percentage of men who opposed tax avoidance was much higher.

The results of the study showed that 1 and 2 were the two most common outcomes. Almost never were men found to be substantially more against tax evasion (McGee & Cohn, 2007). This disparity is attributed to basic gender differences in cognition, emotion, and behavior, according to the theory of self-control (Torgler & Valev, 2010). According to the notion of opportunity, the reason for the divergent opinions is that historically, men have occupied more authoritative positions than women, while women have historically had fewer opportunities. Another study (Torgler & Valev, 2010) likewise discovered that women are much less likely to concur. An additional meta-analysis of research on the morality of tax evasion conducted globally revealed that, on average, people over 50 were among the age range most averse to tax evasion (McGee, 2012). Opposition to tax evasion was lowest among the youngest age group (15–29 years old). These results were explained by the idea that older individuals respect authoritative figures and the law more than younger generations do. Due to their experiences living behind a totalitarian communist dictatorship, elder generations in several former Soviet republics have been found to exhibit less regard for the government. The impact of government faith in compliance and the role of authority in shaping an individual's view of the morality of tax evasion were both underlined by this (Pardisi & McGee, 2023).

Another factor that has been suggested to influence tax evasion in the literature is education. Nevertheless, the results were not definitive. McGee and Tyler (2016) and Kasipillai et al. (2003) discovered that those with lower levels of education are more averse to tax evasion than those with higher levels of education. Song and Yarbrough

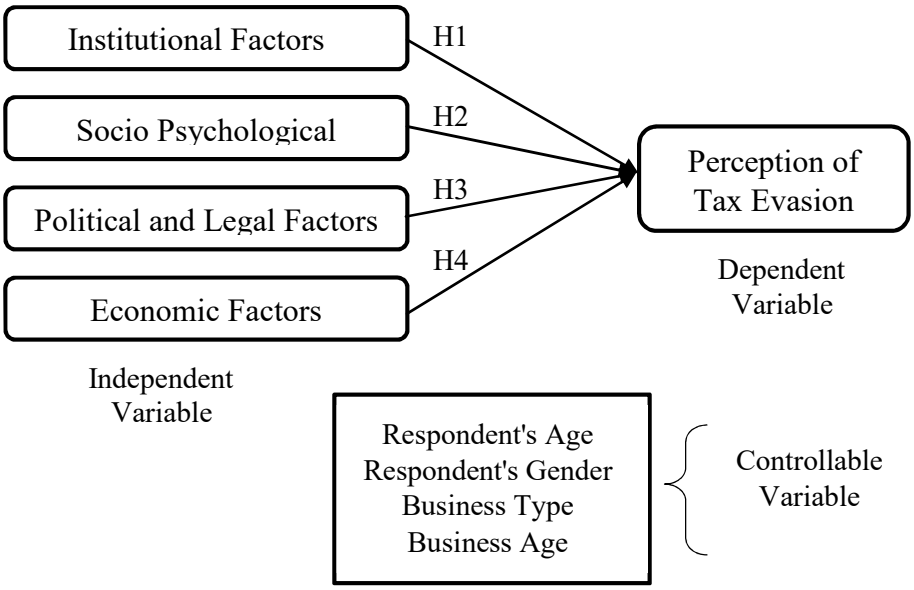
(1978), Wallschutzky (1984), Witte and Woodbury (1985), and Richardson (2006) discovered that the more general education one has, the less tax evasion there is. Income has long been seen to be a significant determinant of tax evasion behavior (Kirchler et al., 2010). Porcano (1988) discovered that those with lower incomes are more likely to evade taxes. According to other research, people in higher income groups are more likely to avoid paying taxes (Anderhub et al., 2001).

This chapter highlights the corpus of historical and contemporary research on the concepts and theories relevant to figuring out what influences undergraduate students' opinions about tax evasion using an example of students from a private university. Before moving on to a more detailed approach that is more relevant to the research issue that will be covered in this research's later sections, viewers will be led through the general concept of tax evasion with the section that follows. The average annual revenue loss from tax fraud and avoidance in developing countries is $385 billion; in the nation of Bangladesh, the NBR calculates that the yearly loss is Tk 400 billion. (Rashid & Ahmad, 2020). Many scholars examined the reasons for tax evasion in developed and developing countries from different ethical views while surveying business students. For instance, the earlier researchers examined business students in China (Fisman & Wei, 2004; McGee et al., 2012), India (McGee and Jain, 2012), and Romania (McGee and Preobragenskaya, 2006). However, most of them investigated it from a philosophical or ethical standpoint. In addition to business students' moral perceptions of injustice, corruption, and prejudice, other factors that may be involved in tax evasion include inadequate enforcement attempts, tax ignorance, the complexity of the system of taxes, and the likelihood of a low audit (Rashid, 2020). However, when undergraduate business students were polled in the previous study, these criteria were ignored. Furthermore, no research has yet been done on the factors impacting business students' opinions on tax evasion in Bangladesh. What factors lead to tax evasion, and what are some practical ways to prevent it? Therefore, by investigating business students' thoughts on tax evasion as a way to address the issue, the current study closes the research gap. Tax evasion reduces output and the amount of money that the government receives.

3. Conceptual Diagram

Based on the data gathered from the secondary data source and empirical evidence, the researchers created a conceptual framework using the study variables.

Figure 1: Conceptual Framework



Based on the conceptual framework, this model will help the researchers collect both primary and secondary data. As a result, one could think of the conceptual framework I employed as a road map for my research. The conceptual framework is as follows.

4. Methodology

Discussion and evaluation of the theory and ideas that were meant to be used critically were taught in the earlier classes. to investigate and determine the factors influencing undergraduate students in Sri Lanka from evading taxes. Building on that structure, this chapter explains the steps and techniques utilized to carry out the research, thereby preparing the viewer for the investigation. As a result, this chapter offers a summary of the research technique, variable conceptualization, sampling tactics, data collection methods, and data analysis methods that aid in the explanation of the unprocessed data collected to solve the research issue that has been sought since the study's beginning. I employ quantitative data and the deductive positive approach in my study, gathering primary data. Primary data will be gathered using a questionnaire in order to examine

the variables influencing undergraduate students' perceptions of tax evasion. The IRD's yearly reports will be the source of data. To ascertain the elements influencing the perception of tax evasion and the connections between socio-psychology, institutions, the economy, and politics. The data was collected from NSBM Green University's undergraduate student body. NSBM Green University's undergraduate business faculty members are included in the sample. There are 375 undergraduate students at NSBM Green University in the sample size for this study. In this study, data analysis was done using descriptive analysis.

5. Data Analysis and Results

A few demographic inquiries open the questionnaire. The data is analyzed using Excel and SPSS software.

5.1 Demographic Information

Table 1: Demographic Information

Demographics	Frequency	Percent	Demographics	Frequency	Percent
Gender			**Education Level**		
Female	243	64.8	Foundation Level	43	11.5
Male	132	35.2	Undergraduate Level	332	88.5
Age					
16 – 20	39	10.4	**Living Area**		
21 – 25	290	77.3	Eastern Province	30	8
26 – 30	33	8.8	Southern Province	66	17.5
31 or Above	13	4.7	Western Province	195	52

5.2 Reliability Testing

Table 2: Reliability Testing

Variable	No of Items	Cronbach Alpha	Description
Institutional Factors	5	0.862	Reliable
Socio-Psychological Factors	4	0.856	Reliable
Political & Legal Factors	4	0.881	Reliable
Economic Factors	7	0.923	Reliable
Perception of Tax Evasion	4	0.816	Reliable

Based on this table, the overall Cronbach's Alpha score for this study is greater than 0.7 for all variables, indicating that it relates to the reliability criteria of the study.

5.3 Correlation Analysis

Table 3: Correlation Analysis

Correlations		Political Factor	Socio_ Factor	Economic_ factor	Instructional_ Factor	Perception
Political_Factor	Pearson Correlation	1	.533**	.595**	.555**	.408**
	Sig. (2-tailed)		0.000	0.000	0.000	0.000
	N	375	375	375	375	375
Socio_Factor	Pearson Correlation	.533**	1	.570**	.691**	.584**
	Sig. (2-tailed)	0.000		0.000	0.000	0.000
	N	375	375	375	375	375
Economic_factor	Pearson Correlation	.595**	.570**	1	.676**	.562**
	Sig. (2-tailed)	0.000	0.000		0.000	0.000
	N	375	375	375	375	375
Instructional_Factor	Pearson Correlation	.555**	.691**	.676**	1	.685**
	Sig. (2-tailed)	0.000	0.000	0.000		0.000
	N	375	375	375	375	375
Perception	Pearson Correlation	.408**	.584**	.562**	.685**	1
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	
	N	375	375	375	375	375

The correlation value between socio-psychology, economic, political, and legal factors and the perception of tax evasion is less than 0.599 and larger than 0.40, indicating a moderate relationship, according to the above table. The correlation value between the institutional and perception of tax evasion is less than 0.799 and larger than 0.60, indicating a strong relationship.

5.4 Regression Analysis

This study will use the regression model to efficiently arrive at a conclusion for the primary research goal. The following is a presentation of the regression model.

POT = β1 (IF) + β2 (EF) + β3 (SPF) + β4 (PLF)

Where,

POT – Perception of tax evasion

β1- β4 - Coefficient of the independent variable

IF – Institutional Factors

PLF – Political and Legal Factors

EF – Economic Factors

SPF – Socio Psychology Factors

Table 4: ANOVA

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	159.020	4	39.755	94.570	.000b
	Residual	155.539	370	0.420		
	Total	314.558	374			

a. Dependent Variable: Perception

b. Predictors: (Constant), Political_Factor, Socio_Factor, r, Economic_facto Instructional_Factor

Based on it, I can formulate a hypothesis. H0: The model is not significant H1: The model is significant.

The table above has a P value of 0.001. The above table's significant value supports the rejection of the null hypothesis, H0 rejected. Thus, it may be said that this model is overall significant.

Table 5: Coefficients

Coefficients[a] Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	0.527	0.129		4.085	0.000
	Instutional_Factor	0.474	0.059	0.467	8.046	0.000
	Economic_factor	0.162	0.051	0.169	3.150	0.002
	Socio_Factor	0.192	0.052	0.195	3.710	0.000
	Political_Factor	-0.052	0.045	-0.055	-1.153	0.250

a. Dependent Variable: Perception

Table 6: Hypothesis Testing

Hypothesis	Standardized Coefficient Beta value	Significant Value	Result
H0: There is no significant relationship between institutional factor and perception of tax evasion H1: There is a significant relationship between institutional factors and perception of tax evasion	0.467	0.000	H0 rejected
H0: There is no significant relationship between economic factor and perception tax evasion. H1: There is significant relationship between economic factor and perception of tax evasion.	0.169	0.002	H0 Rejected
H0: There is no significant relationship between Socio-Psychological factor and perception tax evasion. H1: There is significant relationship between Socio-Psychological and perception of tax evasion.	0.195	0.000	H0 Rejected
H0: There is no significant relationship between political and legal factor and perception of tax evasion. H1: There is a significant relationship between the political legal factor and perception of tax evasion	-0.055	0.250	H0 not rejected

5.5 Model Summary

Table 7: Model Summary Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.711[a]	0.506	0.500	0.64836

a. Predictors: (Constant), Political_Factor, Socio_Factor, Economic_factor, Instructional_Factor

b. Dependent Variable: Perception

The R square was still 0.506. In other words, the independent variable represents 50.6% of the dependent variable.

6. Discussion

Based on the research findings institutional and perception of tax evasion indicate a strong relationship. According to Almeida & Mendonca's [27] research on the combined effects of infrastructure and taxation on economic growth, core public infrastructure has improved economic growth between 1976 and 2011. Though infrastructure has a significant impact on tax revenue collected but not on economic growth, Ayeni & Afolabi [11] used the vector autoregressive technique and discovered that tax revenue influences both economic growth and infrastructure.Re-examining the impact of tax structure of the Nigerian economy's performance while highlighting the interdependent function of infrastructure is relevant given these empirical literature backdrops.(Abeeb Olaniyi et al., n.d.)

The findings show a gap among the old and new member nations' rates of tax evasion. The rates of tax evasion among new members are much greater than those among existing members.There are several ramifications for researchers and policymakers from the study's findings. First, there is evidence that the degrees of tax evasion in the new and old member states varies significantly, which is a matter that EU officials may focus on more. This study looks at the effect of the quality of the institutional environment, although there are other aspects mentioned in the literature as well.

The institutional element significantly positively impacts the perception of tax evasion ($B=0.467$, $P<0.01$). However according to (Awasthi & Bayraktar, 2014) suggests that tax evasion is inversely correlated with regulatory quality (institutional practitioners) that limit corruption, which is in line with earlier research.The most important insight is that reducing tax evasion requires government actions. So far, raising the tax evasion penalty hasn't shown to be a very successful tactic to prevent tax avoidance. There are few penalties that can be applied to these types of offenses, and if the legal repercussions are too harsh, judges may require prosecutors to prove their charges beyond a reasonable doubt. If lawmakers were willing to drive out the financial institutions that have been found to be facilitating tax evasion, the number of evasion providers would

decrease and a high level of tax evasion may be considerably reduced (Alstadsæter et al., 2019).

Economic factors and perceptions of tax evasion are significantly positively impacted (B=0.169, P<0.01), and economic factors have a moderate relationship with the perception of tax evasion. In the EU, tax harmonization is the primary fiscal policy trend; but, since the 2009 financial crisis, there has been a new movement towards fiscal consolidation to lower the public deficit and outstanding liabilities. Economic growth is significantly influenced by fiscal policy. If rates are raised or lowered, the economy will be affected by these fiscal policy actions through a few different pathways. Therefore, tax rates for the public budget should be cut if the government wants to encourage investment. According to earlier academics, there is evidence linking tax evasion with economic evasion negatively. It has been shown that the economic impact of the COVID-19 epidemic has not been uniform for entrepreneurs. Construction, travel, education, hotels, & entertainment are among the business sectors that have been negatively impacted; nevertheless, other sectors, including ecommerce, have profited from opportunities to expand within the industry. (Dissanayake & Damayanthi, 2024), As a result, vulnerable businesses' revenue generation encountered various cash flow problems and mostly reported losses throughout the pandemic. The observation that shifting the penalty base from evaded income to evaded tax lessens the likelihood that tax evasion will rise in tandem with higher tax rates is the pertinent interpretation of the Yitzhaki analysis. In this regard, it makes perfect sense for tax officials to use avoided tax. Evaded taxation is a more effective penalty base than evaded income if the goal of the policy is to prevent decreases in the cost of dishonest behaviour. (Balassone et al., 1998). The business owners may have earlier complied with tax laws, but they are finding it more difficult to do so now. Since there was little correlation between attitudes and effective taxpayer behavior, views regarding the fiscal system are not accurate indicators of a propensity for evasion (Balassone et al., 1998).Moral factors are closely related to compliance since they provide taxpayers with motivation for their actions, claims Halla (2012).Socio-psychological factors significantly positively impact perceptions of tax evasion (B=-0.195, P<0.01). There is a significant positive relationship between socio-psychological factors and perception of tax evasion. According to (Pricope & Borlea, 2023) socio-psychology elements have a significant

influence on tax evasion. Since most attempts did not take into account how tax morale can grow or which factors influence it, it is used as a residuum for capturing unknown influences on tax evasion. Tax enthusiasm is the fundamental desire to comply with and incur taxes and thereby voluntarily support the public good. Morals Among the most important demographic indicators that impact tax compliance are taxpayers' educational attainment and tax deciding factors. A person's morality to pay taxes was not as strongly determined by other factors including their marital status, income level, religion, or demographics (Rantelangi et al., 2017). Politics and legal factors, however, have an insignificant impact on the perception of tax evasion is perceived (B=-0.055, P>0.01). The focus on the cost of taxes is the direct result of tax evasion and how it is seen generally in many nations. When taxpayers feel that necessary fees are excessive in comparison to their income, they resort to tax evasion and fraud in an attempt to reduce their tax obligations, which has negative political and psychological implications (Demalijaj Ukaj, 2014). Nonetheless, it is not appropriate to consider the tax burden's magnitude as a universally applicable relative value. The buying power of income left over after taxes must be considered for the scenario in which we face the same tax burden but under different circumstances (Dragomir et al., 2011). The relationship between political factors and the perception of tax evasion weak positive relationship. According to (Dissanayake & Damayanthi, 2024) political and legal considerations have a negative relationship with tax evasion. An atmosphere that is heavily corrupted will result from a poor legal system. Legal action against noncompliant taxpayers will raise tax collection and decrease tax evasion (Kirchler et al., 2008) It might be difficult to follow tax evasion laws and regulations because they are thought to be greatly impacted by government action. The propose an interaction variable between political connections and a dummy corruption variable in order to evaluate the moderating influence of corruption level on the link between political ties and tax evasion (hypothesis H2). Only in highly corrupt environments can this interaction variable represent the impact of political ties; in other contexts, it takes the value of the political connections variable and returns zero. Results indicate that, in comparison to models 1 and 2, the negative effects of political ties increase in a highly corrupt environment (Coeff = 0.398; t = 5.920). This result supports hypothesis H2, which holds that political ties and tax evasion are mediated by corruption, with the correlation being stronger in

highly corrupt environments. The negative impact of relationship-based economies on taxes is implied by this. Tax evasion is more common in corrupt environments because of the diminished ability of the government to enforce the law, which incentivizes taxpayers to engage in illicit tax management techniques within the framework of the black economy. The results also demonstrate a positive correlation between tax evasion and the political instability variable (Coeff = 0.696; t = 2.920) with regard to the control variables (Khlif & Amara, 2019).

The extent of government involvement might then increase. 0.055 is the standard coefficient's beta value. It is positive. In the regression analysis, the political & administrative variable's P value is 0.250. It is more than 0.05. This suggests that undergraduate student's choices to adopt the perception of tax evasion are not significantly influenced by political or legal issues.

7. Conclusion

For this study, a questionnaire was employed to collect pertinent data from a sample of 375 undergraduates enrolled at NSBM Green University. To do the analysis, SPSS software is employed. A standard coefficient beta value was employed by the researcher to test hypotheses and analyze the impact. For scholarly and policymaking reasons, it is crucial to investigate how undergraduates view tax evasion. The coming generation of taxpayers is represented by undergraduates, and knowing how they feel about tax evasion might help predict future compliance practices. It enables researchers to determine if young adults are likely to defend, excuse, or denounce tax evasion, which might inform the development of tax ethics-focused teaching programs. Governments and educational organizations can use the results of this research to inform the creation of successful programs that educate the public about the negative effects of tax evasion and promote a compliance culture. Furthermore, these studies provide insight into how opinions of tax system fairness are influenced by social, cultural, and academic backgrounds. Policymakers can improve the credibility of the tax structure and future compliance rates by investigating how factors affect to perception of tax evasion and such views early on and making well-informed judgments. In conclusion, undergraduates' perceptions of tax evasion are significantly impacted by institutional, economic, political, and legal factors as well as sociopsychology.

8. Acknowledgement

I would like to sincerely thank everyone who helped to make this research a success in any particular way. My sincere gratitude goes out to my supervisor, Mrs. Gayani Weerasinghe, for her prompt, insightful, and invaluable input as well as her unwavering support during the study task. I want to express my gratitude to the sample group, without whom this study wouldn't have been feasible. Finally, I want to thank my friends and family for their unwavering support.

REFERENCES

Alstadsæter, A., Johannesen, N., & Zucman, G. (2019). Tax evasion and inequality. American Economic Review, 109(6), 2073–2103. https://doi.org/10.1257/aer.20172043

Amjath, M. (2015). TAX EVASION AND NON-COMPLIANCE ATTITUDE OF INCOME TAXPAYERS IN SRI-LANKA. Asia Pacific Journal of Research. www.apjor.com

Awasthi, R., & Bayraktar, N. (2014). Can Tax Simplification Help Lower Tax Corruption? http://econ.worldbank.org.

Carolina, V. (n.d.). The Attitudes of Tertiary Students on Tax Evasion: A Study of Tax Compliance. www.anggaran.depkeu.go.id

Demalijaj Ukaj, S. (2014). Tax Evasion and the Impact on Economic Growth. In ACTA UNIVERSITATIS DANUBIUS (Vol. 10).

Dissanayake, N., & Damayanthi, B. W. R. (2024). Factors Influencing Tax Evasion: The Perception of Sri Lankan Medium-Sized Taxpayers.

Vidyodaya Journal of Humanities and Social Sciences VJHSS, 09(01), 1–26. https://doi.org/10.31357/fh

Fisman, R., & Wei, S. J. (2004). Tax rates and tax evasion: Evidence from “missing imports” in China. Journal of Political Economy, 112(2), 471–496. https://doi.org/10.1086/381476

Kirchler, E., Hoelzl, E., & Wahl, I. (2008). Enforced versus voluntary tax compliance: The “slippery slope” framework. Journal of Economic Psychology, 29(2), 210–225. https://doi.org/10.1016/j.joep.2007.05.004

McGee, R., Aljaaidi, K. S., & Musaibah, A. S. (2012). The Ethics of Tax Evasion: A Survey of Administrative Sciences’Students in Yemen. International Journal of Business and Management, 7(16). https://doi.org/10.5539/ijbm.v7n16p1

Pardisi, A., & McGee, R. W. (2023). Do Age and Gender Make a Difference in the Attitude toward Tax Evasion? Evidence from Five Selected Asian Countries. SSRN Electronic

Journal. https://doi.org/10.2139/ssrn.4378497

Pricope, L., & Borlea, S. N. (2023). SOCIO-DEMOGRAPHIC AND BEHAVIORAL DETERMINANTS OF TAX FRAUD AND TAX EVASION. In Hyperion Economic Journal Year X (Issue 2).

Rashid, Md. H. U., & Ahmad, A. (2020). Business students' perceptions of tax evasion: a study in Bangladesh. International Journal of Accounting and Finance, 10(4), 233. https://doi.org/10.1504/ijaf.2020.10042340

Alstadsæter, A., Johannesen, N., & Zucman, G. (2019). Tax evasion and inequality. American Economic Review, 109(6), 2073–2103. https://doi.org/10.1257/aer.20172043

Amjath, M. (2015). TAX EVASION AND NON-COMPLIANCE ATTITUDE OF INCOME TAXPAYERS IN SRI-LANKA. Asia Pacific Journal of Research. www.apjor.com

Awasthi, R., & Bayraktar, N. (2014). Can Tax Simplification Help Lower Tax Corruption? http://econ.worldbank.org.

Carolina, V. (n.d.). The Attitudes of Tertiary Students on Tax Evasion: A Study of Tax Compliance. www.anggaran.depkeu.go.id

Demalijaj Ukaj, S. (2014). Tax Evasion and the Impact on Economic Growth. In ACTA UNIVERSITATIS DANUBIUS (Vol. 10).

Dissanayake, N., & Damayanthi, B. W. R. (2024). Factors Influencing Tax Evasion: The Perception of Sri Lankan Medium-Sized Taxpayers. Vidyodaya Journal of Humanities and Social Sciences VJHSS, 09(01), 1–26. https://doi.org/10.31357/fh

Fisman, R., & Wei, S. J. (2004). Tax rates and tax evasion: Evidence from "missing imports" in China. Journal of Political Economy, 112(2), 471–496. https://doi.org/10.1086/381476

Kirchler, E., Hoelzl, E., & Wahl, I. (2008). Enforced versus voluntary tax compliance: The "slippery slope" framework. Journal of Economic Psychology, 29(2), 210–225. https://doi.org/10.1016/j.joep.2007.05.004

McGee, R., Aljaaidi, K. S., & Musaibah, A. S. (2012). The Ethics of Tax Evasion: A Survey of Administrative Sciences'Students in Yemen. International Journal of Business and Management, 7(16). https://doi.org/10.5539/ijbm.v7n16p1

Pardisi, A., & McGee, R. W. (2023). Do Age and Gender Make a Difference in the Attitude toward Tax Evasion? Evidence from Five Selected Asian Countries. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.4378497

Pricope, L., & Borlea, S. N. (2023). SOCIO-DEMOGRAPHIC AND BEHAVIORAL DETERMINANTS OF TAX FRAUD AND TAX EVASION. In Hyperion Economic Journal Year X (Issue 2).

Rashid, Md. H. U., & Ahmad, A. (2020). Business students' perceptions of tax evasion: a study

in Bangladesh. International Journal of Accounting and Finance, 10(4), 233. https://doi.org/10.1504/ijaf.2020.10042340

Abeeb Olaniyi, O., Mathew Adekanmbi, A., Adegboyega Opadeji, S., & Dauda Shallie, A. (n.d.). Assessing the Impact of Infrastructure on Tax Structure and Improving Economic Performance: The Case of Nigeria. https://doi.org/10.15826/vestnik.2024.23.3.025

Balassone, F., Bank of Italy, Jones, P., & University of Bath. (1998). TAX EVASION AND TAX RATES: PROPERTIES OF a PENALTY STRUCTURE. In PUBLIC FINANCE REVIEW (Vol. 26, Issue 3, pp. 270–285). Sage Publications, Inc.

Rantelangi, C., Majid, N., & Faculty of Economics and Business, Mulawarman University. (2017). Factors that Influence the Taxpayers' Perception on the Tax Evasion. In Mulawarman International Conference on Economics and Business (MICEB 2017) (Vol. 35) [Conference-proceeding]. http://creativecommons.org/licenses/by-nc/4.0/

PERFUMES AND HEALTH: UNVEILING THE CHEMICAL HAZARDS AND ENVIRONMENTAL CONCERNS

KUMAR S L L

Department of Life Sciences, *Faculty of Science*,

NSBM Green University, Sri Lanka.

lavan.k@nsbm.ac.lk

Abstract

Perfumes have been a significant part of human culture for centuries, valued for their ability to enhance personal and environmental background. Modern perfumes, however, are complex mixtures of synthetic and natural chemicals that may pose health risks. This literature review explores the chemical compositions of perfumes and their potential harmful effects on human health, emphasizing recent research. It discusses the role of synthetic fragrances, allergens, and volatile organic compounds (VOCs) in causing adverse reactions such as skin irritation, respiratory distress, and endocrine disruption. The review also highlights the contrast between synthetic and natural perfumes and their environmental impacts. The findings highlight the need for stricter regulations and consumer awareness regarding the safe use of perfumes.

Keywords: Perfumery, Sustainability, Natural and Synthetic Ingredients, Personalized Fragrances

1. Introduction

Perfumes have long been a part of human civilization, dating back thousands of years to ancient Egyptian and Mesopotamian cultures, where scents were used in religious ceremonies, as personal enhancements, and even in mummification practices. Over time, the use of perfumes evolved, with modern perfumery reaching a pinnacle in the 19th and 20th centuries, as synthetic chemicals began to be introduced, expanding the range of scents available and making perfumes more accessible. Today, perfumes are ever-present in daily life, from personal fragrances to the scents used in cleaning products, air fresheners, and cosmetics. The global fragrance industry, worth billions of dollars, continues to thrive, driven by consumer demand for unique and complex scent profiles (Dugan, 2011).

Perfumes are complex formulations containing a variety of substances that are responsible for their distinctive scents, longevity, and overall sensory appeal. Their chemical composition involves a blend of natural extracts, synthetic chemicals, and other additives. The scent profile can generally be divided into the following categories.

1.1 Scent Profile

Perfume fragrances are composed of three distinct layers: top notes, middle notes, and base notes. Top notes are the initial scents perceived upon application; they are typically light, volatile, and evaporate quickly, lasting only for a short duration. Middle notes, also known as heart notes, emerge as the top notes dissipate and form the core of the fragrance, lingering longer than the top notes. Finally, base notes are the most persistent and deep scents that remain after the perfume has dried down, anchoring the fragrance, and providing depth and richness (Sell & Sell, 2006).

Additionally, the interplay between these notes creates a dynamic fragrance experience, often described as the "fragrance pyramid," which evolves over time as the perfume interacts with the skin and environment. While the exact formulation of a perfume varies, it generally consists of the following components.

1.2 Solvents and Alcohols

Most perfumes are dissolved in alcohol, which acts as a solvent to dissolve the fragrance compounds. Ethanol (ethyl alcohol) is the most used solvent. Alcohol not only helps in dispersing the fragrance molecules evenly, but also aids in their evaporation upon application(Rowe, 2009). The solvent content in perfumes typically ranges from 60-95%, depending on the concentration (e.g., eau de toilette, eau de parfum, etc.). Water and glycerin are sometimes added as co-solvents to modify the texture or performance of the fragrance.

1.3 Fragrance Compounds

Perfumes are composed of volatile aromatic compounds that create the scent profile. These compounds are generally divided into natural essential oils and synthetic molecules.

1.3.1 Natural Fragrance Compounds

Natural ingredients often bring therapeutic benefits due to their inherent bioactive compounds, such as the anti-inflammatory properties of chamomile or the mood-enhancing effects of bergamot.

Lavender oil, with its calming floral aroma, is commonly used as a middle note in fragrances. Rose oil, extracted from rose petals, is versatile and often utilized as either a top or middle note. Citrus oils, such as lemon and orange, contribute a refreshing, zesty fragrance and are primarily used in top notes (Adams & Doucé, 2017).

1.3.2 Synthetic Fragrance Compounds

Synthetic chemicals are widely used in modern perfumery due to their low cost, stability, and ability to mimic more expensive or rare natural scents. Some commonly used synthetic compounds include:

Limonene, benzyl acetate, and musks are examples of aromatic compounds naturally present in flowers, fruits, and other botanical sources, which can also be synthesized for commercial use. Limonene, a terpene found in citrus oils, is widely used in perfumes for its fresh, citrusy scent. Benzyl acetate, a synthetic compound with a fruity, jasmine-like fragrance, is commonly utilized in floral perfumes. Synthetic musks, such as galaxolide, provide a warm, musky base to fragrances. These synthetic musks mimic the scent found in animal secretions, such as those from deer or muskrats, but are preferred for ethical and economic reasons, as animal-derived musks are rare and expensive (Stepanyuk & Kirschning, 2019).

1.4 Fixatives and Stabilizers

These ingredients are added to perfumes to slow down the evaporation of volatile compounds, ensuring the fragrance lasts longer. Natural fixatives, such as resins (e.g. frankincense, myrrh), or synthetic stabilizers like iso e super or ambroxan, are commonly used. These fixatives have little to no scent of their own, but play a critical role in prolonging the longevity of the fragrance (Burger et al., 2019).

1.5 Additives

Other substances, such as colorants and preservatives, are often added to perfumes to enhance their appearance and shelf life. These additives may include compounds like ethyl vanillin (a sweet vanilla-like note), dye (for color), or phenoxyethanol (Adams &

Doucé, 2017). Modern perfumes may also include antioxidants to prevent oxidation of volatile components, enhancing product stability.

In modern perfumery, perfumes are often composed of a combination of natural and synthetic ingredients, with synthetic fragrances becoming increasingly popular due to their lower cost, stability, and ability to replicate complex scents. These synthetic compounds, however, are not without their drawbacks. As the market has expanded, concerns have been raised about the toxicological and ecological consequences of their perfume ingredients and the potential risks they pose to human health and the environment(Shiner, 2015). Recent studies have raised concerns about the health effects of certain synthetic chemicals commonly used in perfumes, such as phthalates, synthetic musks, and volatile organic compounds (VOCs). Some of these chemicals have been linked to allergic reactions, endocrine disruption, and respiratory issues (Basketter et al., 2019). Furthermore, the environmental impact of synthetic fragrances, many of which are not biodegradable, has become a growing issue as researchers explore how these compounds persist in ecosystems and contribute to pollution. For example, synthetic musks have been detected in aquatic systems, with studies indicating potential toxic effects on marine organisms. Wastewater treatment plants are often unable to completely remove these substances, allowing them to enter waterways and accumulate over time (Homem et al., 2015a).

The purpose of this literature review is to investigate the potential health risks associated with chemicals commonly used in perfumes, including synthetic and natural ingredients. It will also assess the environmental implications due to the persistence of certain compounds in ecosystems and their contribution to pollution. By focusing on these critical issues, this review aims to provide a comprehensive understanding of the hazards posed by perfumes to both human health and the environment.

2. Methodology

This literature review was conducted through a careful and thorough search and analysis of scientific articles, reviews, and reports exploring the chemical composition of perfumes and their potential health and environmental effects. The research utilized online databases, including PubMed, ScienceDirect, and Google Scholar, employing keywords such as "Health effects of synthetic fragrances," "Synthetic vs natural

perfume ingredients" and "Volatile organic compounds in perfumes," and "Environmental impact of perfumes." Articles published between 2004 and 2024 were included based on their relevance to the chemical properties and health or environmental impacts of perfumes, ensuring a focus on peer-reviewed journals and reputable academic sources. Extracted data were categorized into key themes, including the associated health risks such as allergies and endocrine disruption, and environmental impacts like bioaccumulation and ecosystem disruption. Furthermore, comparisons between synthetic and natural fragrances in terms of safety, were identified by providing a descriptive overview of the findings related to consumer safety and environmental considerations.

3. Comparison between Synthetic and Natural Perfumes

3.1 Composition and Scent Profile

The fragrance industry has historically relied on both natural and synthetic ingredients to craft perfumes. Natural perfumes are primarily composed of extracts from plants, flowers, and other organic sources, while synthetic perfumes incorporate man-made chemicals designed to replicate or enhance natural aromas. The balance between natural and synthetic components is a crucial factor in modern perfumery, influencing both the fragrance profile and its potential health implications(Sharmeen et al., 2021a).

Natural perfumes tend to have a limited scent profile compared to synthetic ones, as they rely solely on what nature provides. Essential oils from flowers, fruits, spices, and herbs are commonly used to create perfumes with distinct floral, citrus, or woody notes. However, the supply of natural ingredients is often constrained by seasonal availability and geographic location, making them relatively expensive. Moreover, natural ingredients tend to be less stable than synthetics and may degrade over time, leading to changes in the perfume’s scent. As a result, natural perfumes require more careful formulation and storage to ensure consistency (Bauer et al., 2008).

On the other hand, synthetic perfumes offer a much broader range of aromas and can be produced at a lower cost. Synthetic compounds like musk ketone, galaxolide, and linalool can simulate the fragrance of natural substances or create entirely new scents that do not exist in nature. These compounds are often chemically engineered to have better stability, meaning that synthetic perfumes typically last longer and retain their

scent for a longer period. The low cost and stability of synthetic fragrances have made them the dominant choice in the global fragrance market.

A significant advantage of synthetic perfumes is their ability to mimic rare or endangered natural scents without relying on environmentally unsustainable harvesting practices. For instance, synthetic analogs of sandalwood or oud are often used to replace natural extracts, the production of which may contribute to deforestation. Furthermore, synthetic fragrances are often designed to have enhanced diffusion and sillage, making them more impactful in smaller quantities (Sharmeen et al., 2021b).

3.2 Health and Safety Concerns

However, the use of synthetic chemicals comes with its own set of concerns. While many synthetic fragrances are safe for most people, some may trigger allergic reactions, skin irritations, or respiratory issues. Chemicals such as phthalates and synthetic musks, frequently found in synthetic perfumes, have raised concerns regarding their long-term health effects (Sanchez-Prado et al., 2011a). For instance, phthalates are known endocrine disruptors, which means they can interfere with hormone function and may have adverse effects on fertility and development, particularly in pregnant women and young children (Ashcroft et al., 2024).

In contrast, natural perfumes, while generally considered safer, are not without their own risks. For example, essential oils like lavender and eucalyptus can cause allergic reactions in sensitive individuals (Lemmens-Gruber, 2020). Additionally, some plant-based compounds, such as citrus oils, can lead to photosensitivity, increasing the risk of sunburn or skin damage when exposed to UV light (Bitterling et al., 2022). Natural perfumes may be free of synthetic chemicals, however, they still pose certain risks, particularly to those with sensitive skin or allergies.

3.3 Environmental Implications

Natural perfumes are often associated with being more environmentally friendly, as they derive from renewable plant sources. However, the large-scale cultivation of certain perfume crops, such as rose or jasmine, can lead to monoculture farming, reducing biodiversity and straining local water resources. Additionally, the production of natural extracts often requires significant amounts of raw material, contributing to higher carbon footprints.

Synthetic perfumes, on the other hand, require fewer natural resources to produce, making them less reliant on environmentally sensitive agricultural practices. However, their production involves petrochemical processes that contribute to greenhouse gas emissions. Furthermore, synthetic musks, such as galaxolide and tonalide, are persistent in the environment and have been detected in aquatic ecosystems, where they may disrupt the reproductive systems of fish and other aquatic life (Homem et al., 2015a).

The biodegradability of perfume ingredients is another crucial consideration. Studies by A.D. Khan et al. (2019) indicate that synthetic compounds, especially polycyclic musks, are more likely to accumulate in soil and water, persisting in the environment for decades. On the other hand, biodegradable natural components like terpenes break down more readily, although they may still have localized ecological impacts if overused (Khan & Alam, 2019).

In conclusion, both natural and synthetic perfumes offer distinct advantages and disadvantages. Natural perfumes are often viewed as a safer and more environmentally friendly option, but their high cost and limited variety of scents make them less accessible to the mass market. Synthetic perfumes, while more affordable and stable, raise concerns about the potential long-term health effects of certain chemicals. The ongoing debate between natural and synthetic fragrances highlights the need for more research into the safety of perfume ingredients and their potential impacts on human health.

4. Hazardous compounds in Perfumes

4.1 Phthalates

Phthalates are one of the most well-known groups of harmful chemicals found in perfumes. These plasticizers are widely used to increase the flexibility and durability of fragrance formulations by preventing the evaporation of volatile compounds, thus enhancing the longevity of the scent. The most commonly used phthalates in perfumes include diethyl phthalate (DEP) and dibutyl phthalate (DBP). DEP, in particular, is frequently employed due to its ability to dissolve other ingredients and bind the scent to the skin, making it last longer (Sanchez-Prado et al., 2011b).

The concern with phthalates arises from their potential to disrupt hormonal balance. Studies have shown that phthalates can interfere with the endocrine system by

mimicking or antagonizing natural hormones such as estrogen. This hormonal disruption is particularly concerning for reproductive health, especially since phthalates have been linked to decreased sperm quality and altered reproductive development. Although several regions, including the European Union, have banned the use of certain phthalates in consumer products, they remain prevalent in many regions due to their cost-effectiveness and efficacy (Huang et al., 2018a).

Phthalates are well-known for their ability to persist in the environment over long periods. Once they are released into the environment, they do not easily degrade and can accumulate in human tissues and wildlife, contributing to long-term exposure risks (Dutta et al., 2020).Their widespread presence in products such as perfumes underscores the need for safer, more eco-friendly alternatives.

4.2 Synthetic Musks

Synthetic musks are another group of harmful chemicals commonly found in fragrances. These compounds are used as substitutes for natural musks, which are derived from animal sources like deer or musk pods. Due to ethical and environmental concerns over the use of animal-derived musks, synthetic alternatives have become more popular. However, synthetic musks have raised significant safety concerns (Matysiak et al., 2021).

Synthetic musks, such as galaxolide and tonalide, are designed to provide long-lasting fragrance by mimicking the structure of natural musks. They have been widely used due to their ability to enhance scent stability, particularly in formulations aimed at creating rich, deep, and long-lasting fragrances. However, their persistence in the environment is a major drawback. Synthetic musks are difficult to break down, leading to bioaccumulation. This means they can accumulate in the human body over time, potentially resulting in prolonged exposure and health risks.

Several studies have raised concerns regarding the potential endocrine-disrupting properties of synthetic musks. These chemicals have been linked to hormone imbalances, especially in relation to reproductive and neurological health. The long-term effects of continuous exposure, particularly through the skin and respiratory system, remain an area of concern, especially given the widespread use of synthetic musks in the fragrance industry (Patel et al., 2021).

Efforts to develop biodegradable and safer alternatives have been slow, mainly due to the challenges of maintaining the desired scent profiles without compromising performance. As consumers become more aware of these concerns, there is growing interest in transitioning to natural alternatives such as essential oils, though this transition has not been fully realized due to the complexity of scent formulation (Sanchez-Prado et al., 2011c).

4.3 Formaldehyde releasing agents

Formaldehyde-releasing agents are another harmful class of chemicals commonly used in perfumes as preservatives. These compounds help prevent microbial contamination, ensuring the fragrance remains stable and long-lasting.

Common formaldehyde-releasing agents slowly break down over time, releasing formaldehyde, which can cause a range of allergic reactions such as skin irritation, respiratory issues, and even headaches. Sensitive individuals, especially those with conditions like asthma or skin allergies, are particularly at risk of experiencing adverse effects due to exposure to formaldehyde and its derivatives(Lv et al., 2015).

One of the key challenges with formaldehyde-releasing agents is that their inclusion in fragrance formulations helps enhance the product's shelf life, but this also leads to prolonged exposure for consumers, often through prolonged skin contact. Unlike volatile compounds, formaldehyde-releasing agents are not easily removed through simple washing, and users are continually exposed even after application.

There has been some progress in reducing the use of formaldehyde-releasing agents, especially in regions that have implemented strict regulatory frameworks. However, they remain widely used in the fragrance industry, particularly in mass-market perfumes, due to their effectiveness as preservatives (Malinauskiene et al., 2015).

Despite ongoing efforts to reformulate and use safer alternatives, the fragrance industry continues to rely heavily on these harmful chemicals due to their cost-effectiveness and performance characteristics. Regulatory frameworks and consumer awareness are driving shifts toward safer formulations, but challenges remain in achieving truly sustainable and safer options.

5. Health Impacts of Fragrance Compounds

Chemicals present in perfumes can cause a range of adverse health reactions in sensitive individuals, varying from mild irritations to more serious long-term effects depending on the frequency and level of exposure.

5.1 Skin Allergies and Dermatitis

Skin allergies, particularly dermatitis, are among the most common reactions to perfumes, due to ingredients such as limonene, linalool, and citral triggering inflammation, redness, and itching. A study by Kumar M. et al (2021) highlighted limonene and linalool as frequent allergens in patch tests(Kumar et al., 2021). While fragrance-free alternatives are available for individuals with sensitive skin or conditions like eczema, these products may still contain preservatives or masking agents that can cause reactions (Cheng & Zug, 2014). The same review emphasized that oxidation products of terpenes like limonene form more potent allergens over time, particularly when exposed to air. This highlights the importance of proper storage conditions for perfumes to reduce allergenicity. Furthermore, fragrance components in sunscreens and other cosmetic products often causes allergic reactions, increasing overall sensitization rates among frequent users (Mahajan, 2022).

5.2 Respiratory Issues

Respiratory issues are another concern, as perfumes, especially those containing volatile organic compounds (VOCs) like acetone and ethanol, can cause asthma and lead to respiratory sensitization. The American Lung Association reports that these VOCs can irritate the airways, worsening asthma symptoms, and long-term exposure may even contribute to occupational asthma in perfume manufacturing workers. Studies by Angelini et al. (2016) showed that even low-level exposure to VOCs in enclosed spaces significantly increases the risk of airway hyperreactivity in susceptible individuals. Furthermore, terpenes such as limonene, when exposed to indoor ozone, form secondary organic aerosols (SOAs), which worsen respiratory conditions and can lead to chronic bronchitis upon prolonged exposure (Angelini et al., 2016).

5.3 Indoor Air Pollution

VOCs in perfumes also contribute to indoor air pollution, causing headaches, dizziness, and irritation of the eyes and throat when inhaled over extended periods. The World Health Organization identified fragrances as a leading source of indoor air pollutants, particularly in offices and homes where scented products are frequently used. Chronic exposure in these environments is linked to neurological symptoms like migraines, memory impairment, and fatigue (Uhde & Schulz, 2015).

5.4 Endocrine Disruption and Reproductive Health

Endocrine disruption is another potential health risk, particularly from chemicals like phthalates and synthetic musks used in perfumes(Huang et al., 2018b). Phthalates, commonly employed as solvents, can mimic hormones like estrogen, leading to reproductive health issues, with various studies showing reduced sperm quality and potential fetal development effects in pregnant women. Synthetic musks like galaxolide and tonalide, identified as bioaccumulative compounds, have also been detected in breast milk, suggesting potential developmental risks for infants (Ashcroft et al., 2024).

5.5 Neurological and Behavioral Effects

Emerging evidence suggests that some perfume chemicals, particularly synthetic musks, may influence neurological health. Studies by Pinkas et al revealed that galaxolide exposure alters dopamine signaling in animal models, potentially contributing to anxiety and behavioral disorders. Furthermore, chronic exposure to VOCs has been associated with impaired cognitive function, raising concerns about long-term occupational exposure in fragrance-related industries (Pinkas et al., 2017).

6. Environmental Impact

Beyond the direct health effects of perfumes, their production and disposal also have significant environmental implications. The chemical ingredients used in perfumes, particularly synthetic fragrances, can pose a threat to ecosystems when they enter the environment through wastewater or improper disposal. Many of the chemicals in perfumes are not biodegradable, meaning they persist in the environment for extended periods and can accumulate in soil, water, and air (Kraft & Swift, 2005).

6.1 Resource Demands and Habitat Impact

The production of perfumes is resource-intensive, requiring large quantities of raw materials, energy, and water. Natural essential oils, which form the foundation of many perfumes, are often harvested from plant species that are already at risk due to overexploitation. For instance, the production of rose oil and jasmine oil can lead to deforestation and habitat destruction if not sourced sustainably. Furthermore, the distillation process used to extract essential oils is energy-consuming, contributing to carbon emissions and environmental degradation.

According to research by Bridges B. et al. (2004), producing just 1 kilogram of rose oil requires over 3,000 kilograms of rose petals, placing immense pressure on agricultural systems and natural habitats. Additionally, overharvesting of plant species such as sandalwood and agarwood for perfume production has been linked to significant biodiversity loss in tropical regions. Unsustainable sourcing practices have caused certain plant species to be listed as endangered (Bridges, 2002).

7. Challenges of Synthetic Perfume Production

Synthetic fragrance compounds, while less resource-demanding to produce, come with their own environmental challenges. Many of the chemicals used in synthetic perfumes are derived from petrochemicals, which are non-renewable and contribute to pollution through extraction, refinement, and transportation processes. The use of phthalates, synthetic musks, and other petroleum-based compounds in perfumes can lead to the contamination of water bodies, where these chemicals may affect aquatic life(van Soest, 2007). Studies have shown that musks like tonalide and galaxolide accumulate in the environment and in the tissues of animals, potentially causing endocrine disruption in wildlife(Ashcroft et al., 2024). The persistence of these chemicals in the environment makes it difficult to relieve their effects once they have been released into ecosystems.

Research by Kraft P. (2005) highlighted that polycyclic musks, commonly used in synthetic perfumes, are resistant to microbial degradation, leading to their detection in marine sediments and aquatic organisms across multiple regions. These substances have been shown to interfere with the hormonal systems of fish and amphibians, reducing reproductive rates and threatening population sustainability (Kraft, 2005).

The disposal of perfumes, especially synthetic ones, also poses environmental challenges. When perfumes are used and washed off the skin, the chemicals in the products are carried into the wastewater system, where they can contaminate water supplies and harm aquatic organisms. Furthermore, the packaging of perfumes, particularly glass bottles and plastic components, contributes to the growing issue of plastic waste, which can take centuries to decompose in landfills (van Soest, 2007).

Many perfumes are packaged in multi-layered materials, combining glass, plastic, and metal components, which complicates recycling efforts. In response to these environmental concerns, some companies have started to adopt more sustainable practices in perfume production(Anderson, 2016). This includes sourcing raw materials from certified sustainable farms, using recyclable packaging, and reducing the use of harmful chemicals. Some fragrance brands are also turning to natural alternatives, such as plant-based solvents and biodegradable musks, to reduce the environmental impact of their products. However, these efforts remain limited, and more widespread changes are needed to address the broader environmental footprint of the fragrance industry (van Soest, 2007).

8. Conclusion

Perfumes though often perceived as harmless and even beneficial to personal well-being, present complex challenges in terms of their chemical composition, health implications, and environmental impact. While natural perfumes offer a safer alternative for sensitive individuals, they are not entirely free of risks, especially for those with allergies or skin sensitivities. Synthetic perfumes, on the other hand, offer a broader range of scents but introduce concerns about toxicity, endocrine disruption, and environmental pollution.

The fragrance industry must balance consumer demand with ethical and sustainable practices to ensure that perfumes are not only safe for personal use but also for the environment. Future research should focus on identifying safer alternatives to harmful chemicals, promoting sustainable production methods, and enhancing the regulation of fragrance ingredients to mitigate their adverse effects.

Future Perspectives

Research into alternative, non-toxic ingredients is ongoing, and the development of biodegradable synthetic compounds is a priority for many companies. Additionally, the rise of green chemistry could lead to eco-friendlier and human-safe alternatives, while stricter regulations.

REFERENCES

Adams, C., & Doucé, L. (2017). What's in a scent? Meaning, shape, and sensorial concepts elicited by scents. Journal of Sensory Studies, 32(2), e12256.

Anderson, D. (2016). Future Perspective: Design Process of Perfume Packaging.

Angelini, E., Camerini, G., Diop, M., Roche, P., Rodi, T., Schippa, C., & Thomas, T. (2016). Respiratory Health–Exposure Measurements and Modeling in the Fragrance and Flavour Industry. Plos One, 11(2), e0148769.

Ashcroft, S., Dosoky, N. S., Setzer, W. N., & Satyal, P. (2024). Synthetic Endocrine Disruptors in Fragranced Products. Endocrines, 5(3), 366–381.

Basketter, D. A., Huggard, J., & Kimber, I. (2019). Fragrance inhalation and adverse health effects: The question of causation. Regulatory Toxicology and Pharmacology, 104, 151–156.

Bauer, K., Garbe, D., & Surburg, H. (2008). Common fragrance and flavor materials: preparation, properties and uses. John Wiley & Sons.

Bitterling, H., Mailänder, L., Vetter, W., Kammerer, D. R., & Stintzing, F. C. (2022). Photo-protective effects of furocoumarins on terpenes in lime, lemon and bergamot essential oils upon UV light irradiation. European Food Research and Technology, 248(4), 1049–1057.

Bridges, B. (2002). Fragrance: emerging health and environmental concerns. Flavour and Fragrance Journal, 17(5), 361–371.

Burger, P., Plainfossé, H., Brochet, X., Chemat, F., & Fernandez, X. (2019). Extraction of natural fragrance ingredients: History overview and future trends. Chemistry & Biodiversity, 16(10), e1900424.

Cheng, J., & Zug, K. A. (2014). Fragrance allergic contact dermatitis. Dermatitis, 25(5), 232–245.

Dugan, H. (2011). The ephemeral history of perfume: Scent and sense in early modern England. JHU Press.

Dutta, S., Haggerty, D. K., Rappolee, D. A., & Ruden, D. M. (2020). Phthalate exposure and long-term epigenomic consequences: a review. Frontiers in Genetics, 11, 405.

Homem, V., Silva, J. A., Ratola, N., Santos, L., & Alves, A. (2015a). Long lasting perfume–a review of synthetic musks in WWTPs. Journal of Environmental Management, 149, 168–192.

Homem, V., Silva, J. A., Ratola, N., Santos, L., & Alves, A. (2015b). Long lasting perfume–a review of synthetic musks in WWTPs. Journal of Environmental Management, 149, 168–192.

Huang, P.-C., Liao, K.-W., Chang, J.-W., Chan, S.-H., & Lee, C.-C. (2018a). Characterization of phthalates exposure and risk for cosmetics and perfume sales clerks. Environmental Pollution, 233, 577–587.

Huang, P.-C., Liao, K.-W., Chang, J.-W., Chan, S.-H., & Lee, C.-C. (2018b). Characterization of phthalates exposure and risk for cosmetics and perfume sales clerks. Environmental Pollution, 233, 577–587.

Khan, A. D., & Alam, M. N. (2019). Cosmetics and their associated adverse effects: A review. Journal of Applied Pharmaceutical Sciences and Research, 1–6.

Kraft, P. (2005). Aroma chemicals IV: musks. In Chemistry and Technology of Flavors and Fragrances (pp. 143–168). Wiley Online Library.

Kraft, P., & Swift, K. A. D. (2005). Perspectives in flavor and fragrance research. Wiley Online Library.

Kumar, M., Devi, A., Sharma, M., Kaur, P., & Mandal, U. K. (2021). Review on perfume and present status of its associated allergens. Journal of Cosmetic Dermatology, 20(2), 391–399.

Lemmens-Gruber, R. (2020). Adverse Effects and Intoxication with Essential Oils. In Handbook of Essential Oils (pp. 517–541). CRC Press.

Lv, C., Hou, J., Xie, W., & Cheng, H. (2015). Investigation on formaldehyde release from preservatives in cosmetics. International Journal of Cosmetic Science, 37(5), 474–478.

Mahajan, V. K. (2022). Perfumes and associated allergens: A brief review. Cosmoderma, 2.

Malinauskiene, L., Blaziene, A., Chomiciene, A., & Isaksson, M. (2015). Formaldehyde may be found in cosmetic products even when unlabelled. Open Medicine, 10(1).

Matysiak, J., Gorzel, M., & Skrzypek, A. (2021). Synthetic musk odorants in cosmetic products. Arch. Physiother. Glob. Res, 25(1), 43–51.

Patel, S., Homaei, A., & Sharifian, S. (2021). Need of the hour: to raise awareness on vicious fragrances and synthetic musks. Environment, Development and Sustainability, 23(4), 4764–4781.

Pinkas, A., Gonçalves, C. L., & Aschner, M. (2017). Neurotoxicity of fragrance compounds: A review. Environmental Research, 158, 342–349.

Rowe, D. (2009). Chemistry and technology of flavours and fragrances. John Wiley & Sons.

Sanchez-Prado, L., Llompart, M., Lamas, J. P., Garcia-Jares, C., & Lores, M. (2011a). Multicomponent analytical methodology to control phthalates, synthetic musks, fragrance allergens and preservatives in perfumes. Talanta, 85(1), 370–379.

Sanchez-Prado, L., Llompart, M., Lamas, J. P., Garcia-Jares, C., & Lores, M. (2011b). Multicomponent analytical methodology to control phthalates, synthetic musks, fragrance allergens and preservatives in perfumes. Talanta, 85(1), 370–379.

Sanchez-Prado, L., Llompart, M., Lamas, J. P., Garcia-Jares, C., & Lores, M. (2011c). Multicomponent analytical methodology to control phthalates, synthetic musks, fragrance allergens and preservatives in perfumes. Talanta, 85(1), 370–379.

Sharmeen, J. B., Mahomoodally, F. M., Zengin, G., & Maggi, F. (2021a). Essential oils as natural sources of fragrance compounds for cosmetics and cosmeceuticals. Molecules, 26(3), 666.

Sharmeen, J. B., Mahomoodally, F. M., Zengin, G., & Maggi, F. (2021b). Essential oils as natural sources of fragrance compounds for cosmetics and cosmeceuticals. Molecules, 26(3), 666.

Shiner, L. (2015). Art scents: Perfume, design and olfactory art. British Journal of Aesthetics, 55(3), 375–392.

Uhde, E., & Schulz, N. (2015). Impact of room fragrance products on indoor air quality. Atmospheric Environment, 106, 492–502.

van Soest, J. J. G. (2007). Encapsulation of fragrances and flavours: a way to control odour and aroma in consumer products. In Flavours and fragrances: chemistry, bioprocessing and sustainability (pp. 439–455). Springer.

THE IMPACT OF E – PROCUREMENT PRACTICES ON ORGANIZATIONAL PERFORMANCE OF SUPERMARKET CHAIN IN GAMPAHA DISTRICT SRI LANKA

SIRIWARDHANA N M M[1], SHAJA M M M[2], IDDAWALA J[3]

[1]*Wacoal Lanka (Pvt) Ltd, Nittambuwa, Sri Lanka*

[2,3]*Faculty of Business, NSBM Green University, Sri Lanka*

[1]malakasiriwardhana@gmail.com, [2]shaja.m@nsbm.ac.lk, [3]janith.i@nsbm.ac.lk

Abstract

E-procurement plays a crucial role in achieving organizational objectives by extending beyond the facilitation of online transactions to enhance communication with suppliers. This study investigates the impact of e-procurement practices on the organizational performance of a supermarket chain in the Gampaha district of Sri Lanka, focusing on three independent variables: E-tendering, E-payment, and E-invoicing. Employing a quantitative deductive approach, data were collected through questionnaires administered in person to store managers after obtaining their consent. The research instruments were rigorously validated to eliminate potential biases. Findings indicate that the implementation of e-tendering, payment, and invoicing systems significantly improves overall performance, highlighting the importance of managerial knowledge in adopting electronic procurement strategies. This study underscores the necessity for organizations to embrace e-procurement as a means to enhance operational efficiency and strengthen supplier relationships, ultimately contributing to competitive advantage.

Keywords: E-procurement, E-tendering, E-payment, E-invoicing, Organizational Performance.

1. Introduction

In the highly competitive landscape of today's domestic and global markets, organizations must adhere to stringent quality and productivity standards to succeed. To meet or exceed customer expectations while minimizing costs, many industrial firms have adopted lean practices, which focus on maintaining high quality and significantly reducing waste. Implementing lean manufacturing practices such as Just-in-Time (JIT), Total Quality Management (TQM), and Total Productive Maintenance (TPM) together,

rather than separately, significantly improves inventory turnover in Sri Lanka's apparel industry. (K. Jayawardane, S. Musthaffa, & M. Dias, 2022). However, despite the implementation of these lean methodologies, numerous organizations have yet to fully realize their benefits, often due to challenges such as inadequate understanding of lean processes, misalignment between selected tools and specific operational needs, or insufficient application of these tools. As firms evolve, their procurement strategies play a pivotal role in achieving organizational objectives. According to Leenders et al. (2008), effective purchasing practices yield significant advantages for businesses. Consequently, organizational success should be defined through multiple metrics, including quality, efficiency, productivity, profitability, and sustainability. Analyzing e-procurement processes is essential for reaching these objectives; integrating e-procurement into budgeting, supplier selection, and technological advancements is increasingly crucial as consumers demand that companies address environmental and social concerns (Carter, 2011).

The grocery sector faces ongoing pressure to optimize operational costs while enhancing service efficiency and coordination. Streamlined procurement departments are now essential for identifying cost-effective supply sources and reducing overall expenditure on raw materials (Hassanzadeh & Jafarian, 2010). Effective procurement aims to enhance profitability by securing reliable sources and minimizing raw material costs while adapting processes to mitigate environmental impacts. As technology evolves, the grocery industry can leverage e-procurement systems to gain competitive advantages through improved purchasing efficiency and resource management. However, barriers such as resistance to change among employees and leadership indifference may hinder widespread adoption. This study aims to explore the impact of e-procurement practices on organizational performance within supermarket chains in the Gampaha District of Sri Lanka, focusing on key components such as E-tendering, E-invoicing, and E-payment. By examining these relationships, the research seeks to identify potential obstacles and provide insights into optimizing procurement strategies for enhanced operational success.

2. Literature Review

2.1 Balanced Scorecard Theory

The Balanced Scorecard (BSC), introduced by Kaplan and Norton (1992), proposes a holistic approach to organizational management, integrating non-financial measures with traditional accounting to drive productivity. BSC allows organizations to break down broad objectives into specific, measurable sub-goals, offering a structured framework for tracking progress across diverse areas, including employee satisfaction and IT efficiency. This balanced approach to goal-setting aligns with strategic objectives, making BSC a relevant tool for assessing procurement practices and their impact on organizational performance.

2.2 Resource-Based Theory

Resource-Based Theory (RBT) posits that an organization's competitive advantage stems from the strategic value and rarity of its resources, both tangible and intangible. According to Peteraf and Barney (2003), this theory assumes that companies within the same industry may have varied resources, and these differences can contribute to sustained competitive advantages. RBT highlights that unique resources can be leveraged in procurement to enhance efficiency and support long-term success, emphasizing the strategic advantage that emerges when competitors cannot access or replicate such resources. Moreover, Cool et al. (2002) suggest that industries lacking unique resources offer no competitive edge. Hence, procurement practices that focus on acquiring distinct resources contribute significantly to operational efficiency (Barney, 1991), particularly when sourcing relies on innovative, hard-to-replicate techniques.

2.3 Procurement Practices

Procurement practices encompass key organizational activities such as planning, monitoring, and workforce training, which are integral to both strategic and operational functions (Makabira & Waiganjo, 2014). Effective procurement practices have a direct impact on inventory management and operational efficiency, and they play a vital role in enabling organizations to achieve their strategic objectives. In recent years, the digital transformation of procurement, including the adoption of e-procurement systems, has

redefined traditional practices, facilitated enhanced connectivity and streamlined processes within supply chains.

2.4 E-Procurement

E-procurement, a web-based system that optimizes purchasing activities across the supply chain, has been recognized for its ability to improve transaction efficiency, reduce costs, and enhance buyer-seller communication (Parida & Parida, 2005). As Bhaskar (2005) outlines, e-procurement facilitates the digital management of sourcing, vendor selection, ordering, and payments, creating a seamless transaction flow that enhances supply chain transparency and responsiveness. By integrating e-procurement systems, organizations are better positioned to streamline procurement processes, reduce manual workloads, and achieve a more synchronized and efficient approach to purchasing.

2.5 E-Tendering

E-tendering, an aspect of e-procurement, provides several advantages such as reduced bid prices, fewer administrative burdens, and quicker communication channels (Eadie et al., 2007). Empirical evidence suggests that cost and time savings are central to the efficiency of procurement systems (Gebauer et al., 1988). According to Knudsen (2003), the digital approach to tendering enhances procurement strategies by reducing manual invoicing and improving workforce productivity. Consequently, e-tendering supports organizations in achieving faster processing times and minimizing delays in order fulfillment, contributing to a leaner, more agile procurement process.

2.6 E-Invoicing

E-invoicing has become an integral part of modern procurement, offering significant benefits such as cost savings, streamlined processes, and enhanced data security. Benston and Smith (1976) highlight the traditionally high transaction costs associated with manual invoicing, which e-invoicing addresses by lowering infrastructure costs per transaction as volume increases. This digital transformation in invoicing reduces delays and enhances security across the financial supply chain, contributing to an efficient and reliable procurement process that supports long-term organizational goals.

2.7 E-Payment

The e-payment sector, a rapidly growing facet of e-procurement, enables efficient and secure transactions across geographic boundaries (Porter, 2001; Alberta E-Future Centre, 2007). Salnoske (1997) describes e-payments as fostering global connectivity and reduced transaction times, creating value by enabling seamless, round-the-clock purchasing. The ability to conduct real-time transactions makes e-payments particularly valuable in streamlining procurement, allowing for swift payment processing that enhances cash flow and reduces operational delays.

2.8 Organizational Performance

Advancements in supply chain management, coupled with formalized procurement processes, have enhanced organizational performance by reducing costs and improving resource allocation. Effective procurement strategies—such as demand planning, supplier sourcing, and inventory management—are instrumental in achieving organizational success, particularly when ethical procurement standards are maintained (Lysons & Gillingham, 2003). The recruitment of skilled personnel in procurement roles contributes to the accuracy of procurement specifications, thereby enhancing the quality and consistency of procured goods, which ultimately bolsters organizational performance.

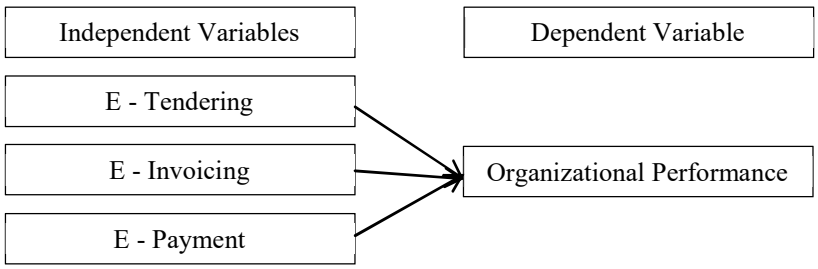
2.9 E-Procurement Practices and Organizational Performance

E-procurement systems are critical in B2B transactions for enhancing internal procurement efficiency and providing data-driven decision-making support (Osmonbekov et al., 2002). Studies reveal that e-procurement contributes to reduced transaction costs, enhanced order accuracy, and closer inter-organizational cooperation, leading to greater operational efficiency (Barbieri & Zanoni, 2005). Davila et al. (2003) further argue that by streamlining procurement processes and fostering collaboration with suppliers, e-procurement systems enable companies to improve performance metrics such as order fulfillment time, inventory costs, and overall administrative expenses in procurement, underscoring the transformative potential of digital procurement practices.

While much of the existing literature has examined the role of ICT in procurement, recent studies suggest that e-procurement holds a unique position in supply chain management due to its potential to improve purchasing effectiveness and interdepartmental collaboration. Despite widespread adoption in various industries, Njihia and Magutu (2013) noted a limited uptake of e-procurement among supermarkets, indicating a gap that this study addresses within the Sri Lankan retail sector. Reviewing literature on organizational performance following e-procurement integration, Ngeno and Omwenga (2010) underscore e-procurement as a robust tool for enhancing departmental collaboration and overall efficiency. This study aims to bridge the research gap by exploring the specific impacts of e-procurement on organizational performance in Sri Lanka, contributing new insights into e-procurement's role in optimizing supply chain and procurement functions in a developing market context.

3. Methodology

This study employs a descriptive research methodology to investigate the impact of E-procurement procedures on the performance of supermarket chains in the Gampaha area. Descriptive research is suitable for providing a comprehensive understanding of phenomena as they exist in their natural settings, allowing for narrative interpretation (Salaria, 2012). The conceptual framework identifies E-Tendering, E-Payment, and E-Invoicing as independent variables influencing organizational performance, which serves as the dependent variable.



H1: There is a significant impact of E- Tendering on organizational performance of supermarket chains in Gampaha District.

H2: There is a significant impact of E - Invoicing on organizational performance of supermarket chains in Gampaha District.

H3: There is a significant impact of E- Payment on organizational performance of supermarket chains in Gampaha District.

The hypotheses guiding this research are framed to assess the relationships between E-procurement practices and organizational performance. Specifically, H1 posits that E-Tendering significantly impacts organizational performance, while H0 suggests no such impact. Similarly, H2 and H3 address the effects of E-Invoicing and E-Payment, respectively, with corresponding null hypotheses.

Data collection was conducted using a survey strategy, which is both cost-effective and conducive to gathering data from real-world contexts. The target population consisted of employees from the procurement departments of Cargills, Keells, and Arpico supermarkets in the Gampaha area. A convenient sampling method was employed, resulting in a sample size of 178 participants. This approach was chosen for its efficiency and accessibility (Malhotra, 2009). Data analysis was performed using SPSS version 27, employing correlation analysis to assess relationships among variables, and regression analysis to estimate associations between dependent and independent variables.

4. Data Analysis & Results

4.1 Reliability Analysis

Table 1: Reliability of Variables

Variables	Cronbach Alpha
E - Tendering	0.773
E – Payment	0.828
E – Invoice	0.804
Organizational Performance	0.907

The analysis reveals that all variables demonstrate a high degree of internal consistency, as evidenced by reliability scores exceeding the threshold of 0.7. This finding underscores the robustness of the measurement instruments employed in this study, indicating that the variables are reliably capturing the intended constructs.

4.2 Correlation Analysis

The statistical analysis conducted in this study reveals significant correlations between various E-procurement practices and organizational performance, as summarized in the following table 2. The Pearson's correlation coefficient for E-Tendering is calculated to be 0.456, indicating a moderate positive correlation with organizational performance.

This correlation is statistically significant, with a p-value of 0.000, suggesting that as the utilization of electronic tendering increases, so does the overall performance of the organization. The significance of this relationship is confirmed at the 0.01 level using a two-tailed test, highlighting the importance of E-Tendering in enhancing organizational effectiveness.

Table 2: Correlation Analysis results

Organizational Performance	
	Pearson Correlation Coefficient
E - Tendering	0.456**
E – Payment	0.409**
E – Invoice	0.257**

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

Similarly, the analysis shows that E-Payment has a Pearson's correlation coefficient of 0.409 with organizational performance. This value also exceeds the threshold for statistical significance, with a p-value of 0.000. The results imply a notable positive relationship between electronic payment systems and organizational performance, indicating that improvements in payment processes are associated with better organizational outcomes. This correlation is significant at the 0.01 level, reinforcing the critical role of E-Payment in driving performance.

Lastly, the correlation coefficient for E-Invoicing stands at 0.257, reflecting a weaker yet still positive correlation with organizational performance. The associated p-value remains negligible at 0.000, signifying statistical significance at the 0.01 level. Although this correlation is less robust compared to E-Tendering and E-Payment, it nonetheless indicates that effective electronic invoicing practices contribute positively to organizational success.

In summary, the findings from this analysis underscore the significant relationships between E-procurement practices, specifically E-Tendering, E-Payment, and E-Invoicing, and organizational performance. The strong correlations observed suggest that enhancing these electronic processes can lead to improved operational outcomes within organizations.

4.3 Multiple Regression Analysis

The regression analysis results are summarized in the following table,

Table 3: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.794	.630	.621	.75732

Predictors: (Constant), E – Tendering, E – Invoice, E - Payment
Dependent Variable: Organizational Performance

The model exhibits a correlation coefficient (R) of 0.794, indicating a strong positive relationship between the predictors (E-Invoicing, E-Tendering, and E-Payment) and the dependent variable, organizational performance. The R Square value of 0.630 implies that approximately 63% of the variance in organizational performance can be explained by these E-procurement practices. The Adjusted R Square value of 0.621 accounts for the number of predictors in the model, providing a more accurate estimate of explained variance.

Table 4: Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	5.372	.329		16.326	.000
	E – Tendering	.459	.112	.370	4.088	.000
	E – Payment	.394	.138	.303	2.859	.005
	E – Invoice	.229	.122	.188	1.886	.041

a. Dependent Variable: Organizational Performance

The coefficient for E-Tendering is 0.459, indicating that a one-unit increase in electronic tendering is associated with a 0.459 improvement in organizational performance, assuming all other variables remain constant. The significance level for this variable is 0.000, which is well below the conventional threshold of 0.05. This result suggests a strong likelihood that electronic tendering positively influences organizational performance, thereby supporting Hypothesis 1 (H1).

The coefficient for E-Payment is 0.394, suggesting that a one-unit increase in electronic payment systems correlates with a 0.394 improvement in organizational performance, with all other variables held constant. The significance level for this variable is reported

at 0.005, indicating a low probability of rejecting the null hypothesis related to electronic payment's impact on performance. This finding supports Hypothesis 2 (H2), confirming that electronic payment systems significantly contribute to enhancing organizational performance.

The coefficient associated with E-Invoicing is 0.229, which implies that a one-unit increase in electronic invoicing corresponds to a 0.229 improvement in organizational performance, assuming all other independent variables are unchanged. The significance level for this variable is 0.041, which falls below the established significance threshold of 0.05 and indicates that the likelihood of rejecting the null hypothesis regarding the impact of electronic invoicing is relatively low at 4.1%. This result supports Hypothesis 3 (H3), affirming that electronic invoicing has a positive effect on organizational performance.

In summary, the regression analysis indicates that all three E-procurement practices such as E-Tendering, E-Payment, and E-Invoicing positively influence organizational performance, with each variable demonstrating statistical significance at the $p < 0.05$ level. These findings underscore the importance of integrating electronic procurement processes within organizations to enhance operational effectiveness and overall performance outcomes.

5. Discussion

The findings from the data analysis reveal significant insights into the relationship between E-procurement practices and organizational performance. The reliability analysis demonstrated that all variables, E-Tendering, E-Payment, E-Invoicing, and Organizational Performance exhibited high internal consistency, with Cronbach Alpha values exceeding the acceptable threshold of 0.7. This suggests that the measurement instruments used in this study are robust and effectively capture the intended constructs (Nunnally & Bernstein, 1994). High reliability is crucial as it enhances the credibility of the research findings and supports the validity of subsequent analyses.

The correlation analysis indicated moderate to strong positive relationships between E-Tendering (0.456), E-Payment (0.409), and Organizational Performance, with E-Invoicing showing a weaker but still significant correlation (0.257). These results align with previous studies that have identified similar positive associations between E-

procurement practices and improved organizational outcomes (Trkman & McCormack, 2010; Gunawadhana et al., 2012). The statistically significant correlations suggest that as organizations increase their adoption of electronic tendering and payment systems, they can expect corresponding improvements in performance metrics. This finding is particularly relevant in today's digital economy, where efficient procurement processes can lead to enhanced operational effectiveness and competitive advantage (Wisner, 2009).

The multiple regression analysis further substantiated these findings by demonstrating that E-Tendering, E-Payment, and E-Invoicing collectively explain approximately 63% of the variance in organizational performance ($R^2 = 0.630$). This indicates a strong predictive capability of the model, suggesting that these E-procurement practices are critical drivers of performance outcomes in organizations. The coefficients for each variable reveal that E-Tendering has the most substantial impact (B = 0.459), followed by E-Payment (B = 0.394) and E-Invoicing (B = 0.229). The significance levels for all three predictors were below the conventional threshold of 0.05, confirming their statistical relevance.These results are consistent with existing literature that emphasizes the importance of integrating advanced procurement technologies to enhance organizational performance. For instance, E-Tendering has been shown to improve communication and coordination among stakeholders involved in procurement processes (Croom et al., 2006), while effective electronic payment systems streamline financial transactions and reduce operational costs (Eyaa & Oluka, 2011). Furthermore, E-Invoicing contributes to better cash flow management and reduces administrative burdens associated with traditional invoicing methods (Soong et al., 2020).

6. Limitations and Recommendations for Future Researchers

This research highlights the need for further investigation into the impact of electronic procurement practices on organizational performance. Future studies should explore a broader range of variables influencing success, including external factors like market conditions and technological advancements. A notable limitation of this study is the small sample size, which may restrict the generalizability of findings. Future researchers are encouraged to increase the sample size to enhance reliability and validity, enabling more robust analyses across different sectors or regions.

Employing diverse measurement techniques will also help organizations comprehensively monitor the benefits derived from e-procurement practices. Additionally, examining the impact of outsourcing purchasing functions on performance is essential, as outsourcing strategies are increasingly adopted by organizations. Longitudinal studies could further assess the long-term effects of e-procurement implementation, revealing trends over time and helping organizations adapt their strategies.

7. Conclusion

This research has successfully elucidated the significant influence of e-procurement practices on organizational performance within the context of Sri Lankan supermarkets. The findings indicate that the implementation of e-tendering, e-payment, and e-invoicing not only enhances operational efficiency but also contributes to a competitive advantage in the marketplace. Specifically, e-tendering facilitates the efficient selection of suppliers across a broader geographical area, thereby improving competitiveness. This is consistent with previous studies that highlight the role of e-tendering in streamlining procurement processes and enhancing supplier relationships (Croom & Brandon-Jones, 2004; Gunawadhana et al., 2012).

Moreover, the positive impact of e-invoicing on performance underscores its potential to expedite tender processing and improve overall operational effectiveness. The study also found that electronic payment methods significantly streamline procedures, leading to increased efficiency and better organizational outcomes. These findings align with existing literature that emphasizes the importance of timely and transparent payment processes in fostering strong supplier relationships and reducing transaction costs (Amani, 2018; Eyaa & Oluka, 2011). To fully leverage the benefits of e-procurement, it is recommended that Sri Lankan supermarket chains integrate all components of e-procurement into their systems. This integration will enhance overall organizational performance by dismantling functional barriers and facilitating seamless data sharing across departments such as marketing, operations, and finance. Additionally, encouraging employee adoption of e-procurement technologies through training and incentive programs is crucial for maximizing their effectiveness. The study also highlights the importance of selecting suitable e-procurement technologies or platforms

to ensure quality information production. Senior management must carefully assess various factors—including risk assessment, future trends, efficacy, and cost—when choosing e-procurement systems that align with the organization's specific needs.

In conclusion, this research not only contributes valuable insights into the relationship between e-procurement practices and organizational performance but also provides practical recommendations for organizations seeking to enhance their procurement processes. Future research should explore the long-term impacts of these technologies on organizational sustainability and adaptability in an ever-evolving business environment. By embracing digital solutions in procurement, organizations can position themselves for continued success in an increasingly competitive landscape.

REFERENCES

Ageshin, E.A. (2001) 'E-procurement at Work: A Case Study,' Production and Inventory Management Journal.

Amani, J. (2018). The impact of electronic payment systems on organizational performance. International Journal of Business and Management Invention, 7(7), 1-8.

Andrea, J.C., and Margaret, T. (2009): "Critical success factors for B2B ecommerce use within the UK NHS pharmaceutical supply chain" International Journal of Operations and production Management, pp 1156- 1185.

Archer, N. (2005) An Overview of the Change Management Process in government, International Journal of Electronic Business, 68-87.

Arnold, U. and Essig, M. (2002). Digital Bidding in Public Procurement: Economic Effects of Electronic Sourcing in the Public Sector, in 11th Annual Intern ational Purchasing and Supply Education and Research Association Conference.Twente University, Netherlands.

Croom, S. & Brandon-Jones, A. (2004). E-Procurement: A strategic approach to a new way of purchasing. International Journal of Operations & Production Management, 24(7), 634-653.

Eyaa, S., & Oluka, P. (2011). E-procurement in developing countries: A case study of Uganda. International Journal of Business and Social Science, 2(23), 104-113.

Gunasekaran, A., & Ngai, E. (2008). Adoption of E- procurement in Hong Kong; An empirical Research, International Journal production economics, pp. 133.

Gunawadhana, W., Jayasuriya, S., & Perera, N. (2012). The impact of e-procurement on supply chain performance: Evidence from Sri Lankan manufacturing firms. Journal of Business Management, 6(3), 45-54.

Hamisi, S. (2010). Challenges and opportunities of Tanzania's SMEs in adapting supply chain management. African Journal of Business Management, pp. 1266- 1276

Hong, W., Zhu, K. (2006). "Migrating to internet based e- commerce: factors affecting e-commerce adoption and migration at the firm level", Information and Management, pp. 204- 221.

Kauffman, J., Kriebel, A. (2008). "Where we're going, Electronic procurement, pp. 27-33. Klakota, Robinson, F. (2009) "Electronic concepts and applications of B2B procurement ",3rd edition, West Publishing company, United States of America, pp.730.

K. Jayawardane, S. Musthaffa and M. Dias, "Impact of Lean Manufacturing on Inventory Turnover Performances: Evidence from the Sri Lankan Apparel Industry," 2022 Moratuwa Engineering Research Conference (MERCon), Moratuwa, Sri Lanka, 2022, pp. 1-6, doi: 10.1109/MERCon55799.2022.9906192.

LaMarco, N. (2018). The benefits of e-invoicing for suppliers and buyers. Retrieved from https://www.trginternational.com/the-benefits-of-e-invoicing-electronic-invoicing

Matano, J., Ouko, J., & Ibem, E. (2020). Effects of E-Procurement on Supply Chain Management in the Modern Business Environment. International Journal of Social Sciences and Entrepreneurship, 2(2), 204-220.

Qvalia. (2024). E-invoicing in Europe: Impact analyzed in new EU report. Retrieved from https://qvalia.com/e-invoicing-in-europe-impact-on-market-and-procurement-in-new-eu-report/

TRG International. (2024). The benefits of e-invoicing (electronic invoicing). Retrieved from https://blog.trginternational.com/the-benefits-of-e-invoicing-electronic-invoicing

Wu, F. (2007). "Antecedents and outcomes of e- procurement adoption: an integrative model", IEEE Transactions on Engineering Management, No. 3, pp. 576.

Waithaka, R. K., & Kimani, J. G. (2021). Effect of E-Procurement Practices on Supply Chain Performance. Global Journal of Purchasing and Procurement Management, 32–42.

Williams, S. and Hardy, C. (2007). E-Procurement: Current Issues and Future Challenges: proceedings of the European Conference on Information Systems (ECIS 2006), 12–14 June, Go¨teborg, Sweden, 131–142.

DO BUSINESS UNDERGRADUATES HAVE AN INTENTION OF ENGAGING IN SOCIALLY RESPONSIBLE INVESTMENTS? THE CASE OF SRI LANKA

DE ALWIS W H A I U, BANDARA Y. M. S. W

Department of Accounting and Finance,

Faculty of Business, NSBM Green University, Sri Lanka

whaiudealwis@students.nsbm.ac.lk, sunarib@nsbm.ac.lk

Abstract

Using the Theory of Planned Behaviour (TPB), the study investigates how attitude, subjective norms, and perceived behavioural control influence undergraduates' intention to participate in socially responsible investments (SRI). The primary goal was to understand what motivates undergraduates to invest in companies that prioritize ethical, social, and environmental concerns in addition to financial returns. The study employs a quantitative research method, with data collected via a structured self-administered questionnaire from 375 undergraduates pursuing business-related degrees at both private and public universities in Sri Lanka. The data was analysed using PLS-SEM with the aid of SmartPLS software. Results indicated that attitudes, subjective norms, and perceived behavioural control significantly impact the socially responsible investment (SRI) intention among business undergraduates in Sri Lanka. The findings also show a lower awareness on socially responsible investment among business undergraduates in Sri Lanka. While confirming that attitudes, social norms and perceived behavioural control are paramount in developing SRI intention among undergraduates in Sri Lanka, the study identifies that socially responsible investment awareness and empowerment is critical for developing the next generation of socially responsible investors.

Keywords: Attitude, Perceived behavioural control, Socially Responsible Investment, Subjective Norms, Theory of planned behaviour, Undergraduates

1. Introduction

Investment is a financial commitment made with the expectation of future advantages, such as real estate, durable products, or financial assets (Bodie et al., 2018). Today, many people prefer to invest their money rather than simply retain it, as keeping money

at hand adds no value. There are various investment options available, including stocks, bonds, unit trust funds, insurance, and options. In the past, businesses primarily followed the profit-maximization economic model, focusing solely on financial advantages. This narrow perspective often had serious negative consequences for the environment, prompting a shift in investment methods to more sustainable ones (Marti et al., 2024). The exchange environment has developed as an important concept, recognizing that marketing expenses extend far beyond financial expenditure. Social responsibility investing is a trend that incorporates the environmental and social implications of investments into financial analysis. Socially responsible investors prioritize investments that have a positive impact on the environment and society, such as environmentally friendly companies (Marti et al., 2024). Social responsibility investment is gaining popularity in the stock market, both domestically and internationally, as a response to environmental concerns.

In the Sri Lankan context, the country's environment is particularly amenable to an examination of this association due to several reasons (Kumari, 2020). Compared with firms in Western countries, Asian firms operate in an environment with weaker investor protection, less developed capital markets, and a heavier presence of dominant owners with the ability and means to influence corporate decisions. Also, the country has not yet placed due recognition to the importance of pursuing sustainable investments, despite its role in contributing to the achievement of Sustainable Development Goals (SDGs). The foreign reserve management activities of CBSL could be considered a vital steppingstone for Sri Lanka to embark on sustainable investments and show support and encouragement to other Sri Lankan investors (Central Bank of Sri Lanka, 2022).

Unethical business investment practices in Sri Lanka have significantly impacted environmental and social problems(Ilangakoon & Silva, 2024; Wijayasinghe, 2023). Most businesses in the country focus on profit maximization, neglecting their responsibility to society and the environment (Swarnapali, 2019; Wijesinghe, 2012). This has led to the destruction of the ecological system and society. In developed countries, social responsibilities are given more attention, but there is a lack of empirical evidence for this intention among Sri Lankan investors. The concept of socially responsibile investment is not popular among investors in Sri Lanka, as they are mainly concerned with maximizing their wealth by investing in companies that make huge

profits. This often leads to negative impacts on both the economy and the community, ultimately affecting the quality of life for all individuals involved. Businesses must prioritize sustainability to create a positive impact on society. Sri Lanka faces various environmental-related issues, such as environmental pollution and garbage increase, which began with the Industrial Revolution (Wijesekara et al., 2014). A survey by the Asia Foundation and the Environmental Foundation Limited identified 150 sources of pollution, mainly from industries involved in food production, beverages, ceramics, textiles, clothing, oil refining, tanning, fertilizers, and plastics (The Asia Foundation., n.d.).

The growing availability of local and global information has given citizens greater power to shape corporate conduct. Customers and investors can put pressure on businesses to emphasize social responsibility, as when businesses don't behave ethically, customers can avoid them and choose rivals with stronger ethical standards. To satisfy the rising demands of socially conscious investors and customers, businesses are realizing the importance of incorporating ethical and social issues into their operations. Sri Lankan Business Management Undergraduates represent the future generation of investors who are about to make important financial decisions (Kumari, 2020), whose investment intentions will shape the future of the Sri Lankan economy. Understanding their intentions towards socially responsible investment is critical as it can lead to more socially responsible financial markets in the long run. Socially responsible investment intention enables business management, and young people have good financial literacy and intention to invest in ethical investments.(Kumari, 2020; Malzara et al., 2023). This awareness can help them become more informed investors and be better prepared to handle the changing landscape of responsible investing. In this light, with the purpose of understanding the determinants of socially responsible investment intention among Business undergraduates in Sri Lanka, the researchers identify the following research questions:

Research Questions

Main research question: What are the attributes that can impact Socially Responsible Investment Intention in Sri Lankan Business Undergraduates?

In investigating the main research question, the following sub research questions were developed:

1. What is the impact of attitude on SRI intention among Sri Lankan Business Undergraduates?
2. What is the impact of subjective norms on SRI intention among Sri Lankan Business Undergraduates?
3. What is the impact of perceived behavioural control on SRI intention among Sri Lankan Business Undergraduates?

In the attempt of answering the developed research questions, the following objectives were devised:

1. To investigate the impact of attitude on SRI intention among Sri Lankan Business Undergraduates.
2. To examine the impact of subjective norms on SRI intention among Sri Lankan Business Undergraduates.
3. To analyse the impact of perceived behavioural control on SRI intention among Sri Lankan Business Undergraduates.

2. Literature Review

The current study examines the research questions formulated with its theoretical base lying in the theory of planned behaviour.

2.1 Theory of Planned Behaviour

The Theory of Planned Behaviour (TPB) is an extension of the theory of reasoned action, focusing on intentions and actions based on an individual's attitude, subjective norm, and perceived behaviour control (Ajzen, 1991). The theory consists of the following components:

1. Attitude Toward the Behaviour which refers to an individual’s positive or negative evaluation of performing a behaviour.
2. Subjective Norms which refer to the perceived social pressures to perform or not perform a behaviour.
3. Perceived Behavioural Control which refers to the perceived ease or difficulty of performing the behaviour.

4. Behavioural Intention which represents the degree of effort an individual is willing to exert to perform the behaviour and is the key mediating variable that predicts actual behaviour.

Stronger intentions are likely to lead to behaviour, especially when attitudes, subjective norms, and PBC are all favourable (Ajzen, 1991). These components work together to predict behaviour. Positive attitudes, supportive social norms, and a high level of perceived control increase the likelihood that an individual will intend to perform a behaviour and, consequently, act on that intention (Ajzen, 1991). It has been widely applied to understand and predict various human behaviours, including agriculture, information technology, service, financial, and health sectors (Arslan & Şar, 2018; Park & Ohm, 2014; Verma & Chandra, 2018; Wang et al., 2018). TPB has been found to accurately predict intentions and behaviours in pro-environmental areas, such as green purchasing, low carbon consumption, waste separation (Grilli & Notaro, 2019; Judge et al., 2019; Verma & Chandra, 2018), and socially responsible investments (Adam & Shauki, 2014).

2.2 Socially responsible investments (SRI)

Financial initiatives that try to integrate ethical, social, environmental and/or corporate governance concerns into the investment process are constituent of SRIs (Sandberg et al., 2009). In the late 1990s, socially responsible investment (SRI) gained attention for environmental sustainability, driven by disasters and increased awareness of ozone depletion and global warming (Lewis & Mackenzie, 2000; Pienitz & Vincent, 2000; Richardson, 2008; World Commission on Environment and Development, 1987). However, some companies struggle to achieve ecological sustainability. This trend is expected to shift towards mainstreaming SRI and addressing sustainability threats, with SRI becoming more inclusive and comprehensive (Heinkel et al., 2001; Sparkes & Cowton, 2004).

2.3 Global trends in Socially Responsible Investments

Socially Responsible Investment (SRI) is gaining popularity as investors prioritize environmental performance in their investing decisions. By 2014, over one in six dollars managed professionally in the US went towards SRI, totalling $6.57 trillion (Dilla et al.,

2016). SRI makes up 22%-38% of professionally managed assets in the USA, Canada, Europe, and Australia. 80% of institutional investors include ESG issues in their investment strategies, with the potential to account for over $140.5 trillion worldwide by 2025 (Jonwall et al., 2023). The expansion of SRI has been promoted by the United Nations-sponsored Principles of Responsible Investment (PRI), with over 1,400 signatories managing $59 trillion in assets by 2015. Currently, Asian countries are actively contributing to the global expansion of sustainable investing as well; for instance, between 2014 and 2016, China and India had growth rates of 105% and 104%, respectively. (Jonwall et al., 2023). Investors now seek companies that support sustainability and ethical practices, with a focus on renewable energy, waste reduction, and social equity projects (Oehmke & Opp, 2024; Jonwall et al., 2023; Pick-Soon et al., 2024).

2.4 Socially Responsible Investment in Sri Lanka

Sri Lanka's corporate sector is being urged to act environmentally and socially responsibly to address climate change, sustainable development, and population growth. However, companies prioritize increasing shareholder wealth over meeting the needs of all stakeholders (Madhavika et al., 2021; Swarnapali, 2019). The Chartered Accountants of Sri Lanka (CA) introduced a code of best practices focusing on Corporate Governance, which improved disclosure related to governance variables (Wijesinghe, 2012). Sri Lanka is embarking on a transformative journey to build a sustainable, resilient economy, aiming for a paradigm shift in sustainable finance mobilization (Economic and Social Commission for Asia and the pacific, 2023). However, Sri Lankan firms' lower level of CSR disclosure may be due to family ownership, lack of understanding of social responsibility, and lack of mandatory CSR reporting (Dilrukshi, 2022).

2.5 Dimensions related to Socially responsible investment intention

1. Attitudes and Socially Responsible Investment Intention

Previous studies indicate that attitude is a significant predictor of behavioural intention (Ajzen, 1991; Ajzen & Fishbein, 1969). Attitude is an affective or valence response to engaging in behaviour; in other words, it expresses a person's propensity, whether

favourable or unfavourable, towards engaging in a specific behaviour in a given circumstance (Ajzen, 1971). The choice of SRI is determined by an investor's attitudes toward moral, environmental, and societal concerns. Individuals have grown concerned about their social image and are attentive to market trends, which reinforces their willingness to participate in SRI (Thanki et al., 2022). A recent study identified that investors' positive attitudes and peer influence led them to invest in SRI (Raut et al., 2020). As a result, the study supports significant and positive relationships between attitudes and intentions for SRI investment. Investors' favourable or unfavourable preferences for SRI investment behaviour are directly correlated with their casual path from attitude to intention. This result is consistent with previous research findings (Adam & Shauki, 2014; Zhang & Huang, 2024) and has strong empirical support. In the case of SRI, attitudes have been shown to significantly influence intentions (Adam & Shauki, 2014). Hence, the currents study posits that

H1: There is a significant relationship between Attitude and SRI intention

2. Subjective Norms and Socially Responsible Investment Intention

The subjective norm construct in this study can be defined as an individual's belief about whether to engage in a particular behaviour based on his or her perception, even if it does not reflect the true opinions of others (Belgiawan et al., 2017). As the study by Adam and Shauki (2014) reveal, on par with Subjective norms, behaviour is influenced by beliefs about whether others significant to a person agree with his/her actions. It's thought to assess the social pressures on people to perform or not perform a specific behaviour. Literature identifies that Subjective norms and socially responsible investment intention have a significant direct relationship.(Adam & Shauki, 2014; Raut et al., 2020). The current study hence posists that

H2: There is a significant relationship between Subjective Norms and SRI intention

3. Perceived Behavioural Control and Socially Responsible Investment Intention

PBC is commonly thought to be influenced by resources, knowledge, and obstacles that can either help or hinder one's ability to perform the referent behaviour. The relationship between PBC and behavioural intention was confirmed by extant literature (Al Mamun

et al., 2018; Yee et al., 2022). It has been discovered that perceived behavioural control has a significant influence on pro-environmental behaviours in energy conservation (Albayrak et al., 2013), as well as in household items such as soaps, toilet paper rolls, laundry detergents, and dishwashing solutions (Arli et al., 2018). Individuals' perceptions of their ability to control the use of eco-labelled products influence their willingness to purchase them. Previous studies also identify that perceived behavioural control has a significant impact on the intention (Thanki et al., 2022; Adam & Shauki, 2014; Ratu Balqis Malzara et al., 2023). Hence, the current study posits that

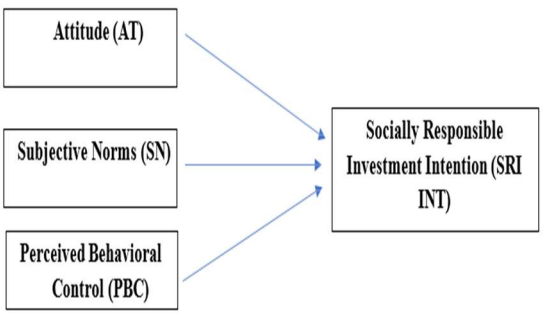
H3: There is a significant relationship between Perceived Behavioural Control and SRI intention

3. Methodology

This study investigates the impact of attitudes, subjective norms and perceived behavioural control on SRI intention among business undergraduates in Sri Lanka in a deductive approach based on the Theory of Planned Behaviour (TPB). The conceptual framework utilized is illustrated in Figure 1. Analysis was conducted quantitatively, using descriptive statistics to summarize the dataset and correlation analysis to determine the degree and direction of correlations between key factors. Partial least squares structural equation modelling was used to assess the effects of these variables on SRI intentions. A cross-sectional survey among a purposive sample was used to gather data from August to September 2024, allowing for rapid data collection and statistical analysis.

Figure 1 Conceptual Framework

Source: Author Compiled



3.1 Population and Study Sample

Potential individual investors at the undergraduate level in Sri Lanka is the population of this study. Specific focus is given to Business undergraduates who have been studying in Sri Lankan public and private universities since the 2021- 2024 academic year. They have been chosen as the population for study because they are at a critical juncture in their financial growth, and undergraduates frequently make their first investment and savings decisions. Moreover, they have better Financial Literacy and take courses in Financial Management which provide them with fundamental knowledge and interest in Business, financial markets, investment strategies, and economic principles, making them more likely to engage with and comprehend concepts related to socially responsible investment (SRI) intention (Kumari, 2020; Ratu Balqis Malzara et al., 2023). The purposive sampling method was used to reach 375 undergraduate students who were studying at private and government universities and were pursuing business management degrees. The sample is deemed sufficient according to the Krejcie and Morgan table (Krejcie & Morgan, 1970).

3.2 Data collection

Data for this study was gathered from primary data sources. The primary data for the research was collected using Google Form surveys. A structured self-administered questionnaire was used to collect data with closed-ended questions. It gathered information on demographics, respondents' Attitudes, Social norms, perceived behavioural control and SRI intention. This complies with the previous research related to this topic which followed the same method for gathering the data (Adam & Shauki, 2014; Raut et al., 2020; Thanki et al., 2022; Yee et al., 2022).

3.3 Research instrument

The three exogenous variables (AT, SN, and PBC) and the endogenous variable (INT) were measured using 5-point Likert scales from strongly disagree (1) to strongly agree (5) developed and used in extant literature. The questions measuring attitude were adapted from the study by (Singh et al., 2021). Subjective norms was measured using the questions adapted from Ajzen (2006). Perceived behavioural control was measured

using an adaptation of the scale by Kumar & Basu (2023). SRI intention was measured by adapting the questions from Ajzen (2006).

4. Findings and Discussion

The collected data was initially analysed in SPSS and then using PLS-SEM with the aid of SmartPLS software. PLS-SEM was chosen because of its ability to accommodate small sample sizes, normality of the data distribution not being a pre-requisite, and its ability to handle complex models with many indicators (Hair et al., 2014). No missing values were detected since all questions were made mandatory in the Google Form.

4.1 Respondents' Demographic Profile

The demographic profiles of a total of 375 Business Management undergraduate respondents (Gender, Age, Degree program, Study Year, Socially Responsible Investment Awareness in Si Lanka) were analysed, and the results are displayed in Table 1. The gender distribution indicates a slight majority of female respondents. Of the 375 participants, 211 (56.3%) were women and 164 (43.7%) were men. The bulk of respondents are between 21 and 26 years old, with 136 (36.3%) in the 21-23 age group and 167 (44.5%) in the 24-26 age group. A smaller proportion, 56 pupils (14.9%), are over the age of 26, with only 16 students (4.3%) aged 18 to 20. The highest number of students are in their fourth year of study, with 197 (52.5%), followed by 78 (20.8%) in their third year, indicating that the majority of respondents are in the late stages of their undergraduate programmes. Of the 375 participants, 214 (57.1%) indicated they were unaware of Socially responsible investments whereas 161 students (42.9%) said they were knowledgeable. This indicates that a significant number of students are unaware of socially responsible investing.

Table 1: Respondents' Demographic Profile

Source: Survey Data (2024)

Variable	Frequency	Percentage (%)	Mean
Gender			
Mal	164	43.7	1.56
Female	211	56.3	
Age			
18-20 years old	16	4.3	2.70

21-23 years old	136	36.3	
24-26 years old	167	44.5	
More than 26 years	56	14.9	
Years of Study			
1st Year	43	11.5	3.14
2nd Year	57	15.2	
3rd Year	78	20.8	
4th Year	197	52.5	
SRI Awareness in Sri Lanka			
Yes	161	42.9	1.57
No	214	57.1	

4.2 Measurement model evaluation

As the latent constructs are independent of the measures used, the measurement model in the current study is deemed as reflective (Borsboom et al., 2003), with items linked by a common idea (Rossiter, 2002). The evaluation of reflective models follows four steps: assessment of indicator reliability, internal consistency, convergent validity, and discriminant validity (Hair et al., 2019).

4.2.1 Indicator reliability

Based on outer loadings, the indicator reliability was assessed. Since all reflective indicators reported loadings above 0.7, all were retained as per Hair et al. (2014).

4.2.2 Internal consistency and Reliability

Internal consistency and reliability were assessed using two metrics: Cronbach's alpha and composite reliability (rho_a and rho_c). Values for both above 0.7 indicate internal consistency (Hair et al., 2014).

Table 2: Cronbach's Alpha, Composite Reliability, and Average Variance Extracted (AVE)

Source: Survey Data (2024)

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
AT	0.910	0.910	0.933	0.735
INT	0.953	0.953	0.964	0.842
PBC	0.901	0.904	0.926	0.715
SN	0.912	0.917	0.934	0.738

In the current study, both Cronbach's alpha and composite reliability values (rho_a and rho_c) exceed 0.7 (Table 2), indicating the internal consistency and reliability.

4.2.3 Convergent validity

Convergent validity is the degree to which a measure correlates positively with other measures of the same construct (Hair et al., 2014). Hair et al. (2014) highlight the significance of Average Variance Extracted (AVE) in assessing convergent validity, with ideal values exceeding 0.5. In the current study, the AVE value exceeds 0.5 (Table 2), indicating convergent validity.

4.2.4 Discriminant validity

Discriminant validity is the extent to which a construct is different from other constructs, indicating that it captures distinctive phenomena not focused by others in the model. As per Hair et al. (2014), the Heterotrait-Monotrait (HTMT) ratio is used to assess discriminant validity, with values being preferably below 0.85 and below 0.90 for conceptually similar constructs. The HTMT ratios of the current study are below 0.85 for three pairs of constructs. The remaining three pairs also lie below 0.90 which is acceptable (Table 3).

Table 3: HTMT ratios

Source: Survey Data (2024)

	AT	INT	PBC	SN
AT				
INT	0.821			
PBC	0.897	0.859		
SN	0.822	0.806	0.898	

4.3 Structural model evaluation

The inner model is evaluated in two steps: assessing the significance of the structural model relationships and assessing the explanatory power of the model.

4.3.1 Assessment of the significance of the structural model relationships

Estimates for the structural model relationships, particularly, the path coefficients that show the proposed relationships between constructs, are obtained when the PLS-SEM

method is applied (Hair et al., 2014). Table 4 displays the path coefficients that were obtained along with their interpretations.

Table 4: Path coefficients

Source: Survey data (2024)

	Path coefficient	Interpretation
AT -> INT	0.275	A one-unit change in attitude changes the SRI intention by 0.275 when all other factors remain constant
PBC -> INT	0.381	A one-unit change in perceived behavioural control changes the SRI intention by 0.381 when all other factors remain constant
SN -> INT	0.241	A one-unit change in social norms changes the SRI intention by 0.381 when all other factors remain constant

The p-values of the path coefficients were obtained using a bootstrapping procedure in order to evaluate the significance of these relationships. Hair et al. (2014) state that p-values, t-values, and confidence intervals can all be used to evaluate the importance of path coefficients. Table 5 presents the path coefficients, p-values and t-values for the current study's model. All constructs are significant predictors at a 95 per cent significance level, with p-values less than 0.05. Hence, all hypotheses developed (H1, H2 and H3) are accepted at a 95 percent significance level.

Table 5: Path Coefficients, t-values, p-values and the significance

Source: Survey data (2024)

	Path coefficient	Standard deviation	T statistics	P values	Hypothesis testing
AT -> INT	0.275	0.065	4.259	0.000	Accepted
PBC -> INT	0.381	0.109	3.504	0.000	Accepted
SN -> INT	0.241	0.092	2.634	0.008	Accepted.

4.3.2 Assessment of the model's explanatory power

Hair et al. (2014) state that R2 (coefficient of determination) is the most common measure assessing the explanatory power of a structural equation model, with higher values indicating higher predictive accuracy. The structural equation model which predicts socially responsible investment intention using the independent variables attitude, subjective norms, and perceived behavioural control, has moderate predictive accuracy with a R2 value of 0.699 and an adjusted R2 value of 0.696 (Table 6).

Table 6: R square and Adjusted R square

Source: Survey data (2024)

	R-square	R-square adjusted
INT	0.699	0.696

The R2 value indicates that the variance in SRI intention explained by the exogenous variables (Attitude, perceived behavioural control, Social norms) is 69.9 per cent.

The f2 indicates the change in the R^2 when a specified exogenous variable is omitted from the model and explains if the omitted variable has a significant impact on the endogenous variables. Table 7 represents the f2 effect size of the current model, and each value is greater than 0.02, but less than 0.15, indicating small effect sizes (Hair et al., 2014). Accordingly, it can be stated that all exogenous variables have significant impacts on the SRI intention. The current study explores factors influencing Sri Lankan Business students' intention to engage in Socially Responsible Investment (SRI), focusing on attitude, subjective norms, and perceived behavioural control. The results reveal significant impacts from the predictor variables on SRI intention, demonstrating that all three elements play important roles in shaping SRI intention among Sri Lankan Business undergraduates. Findings also reveal a significant gap in awareness on SRI, highlighting the need for improved awareness campaigns.

Table 7: f^2 effect size

Source: Survey data (2024)

	f-square
AT -> INT	0.079
PBC -> INT	0.117
SN -> INT	0.060

The first hypothesis (H1) postulated that attitudes had a significant impact on SRI intentions. The study found that attitudes indeed have a significant positive impact on SRI intentions, which is consistent with prior literature (Adam & Shauki, 2014; Ajzen, 1991; Ratu Balqis Malzara et al., 2023; Raut et al., 2020; Yee et al., 2022). Participants who believe SRI is ethical and useful to society are more likely to invest in such endeavours. This finding aligns with the growing trend of ethical purchasing (Pick-Soon et al., 2024). The significant influence of attitude on SRI intention can be related to respondents' educational backgrounds, particularly those in their third and fourth years

of study, which may have exposed them to ideas like corporate social responsibility, ethics, and sustainability.

The second hypothesis (H2) posited that subjective norms have a significant impact on SRI Intention. The results revealed that subjective norms do have a significant positive impact on SRI intention among Business undergraduates, falling in line with extant literature (Adam & Shauki, 2014; Raut et al., 2020). This highlights the importance of social influence in shaping financial behaviour. Undergraduates, who are at the beginning of their financial adventures, value the opinions of friends, family, and mentors on their investment decisions. Hence, financial educators, governments, and corporations could promote ethical and socially responsible investment practices by using social networks, with the support of famous individuals or peer groups potentially increasing socially responsible investment in Sri Lanka.

The third hypothesis (H3) suggested that perceived behavioural control has a significant impact on SRI intentions. Confirming the hypothesized relationship, the study established a significant positive impact from perceived behavioural control on SRI intention, as in extant literature. This finding is consistent with Ajzen's (1991) TPB model, and prior studies by Al Mamun et al. (2018) and Yee et al. (2022), which emphasize the importance of perceived behavioural control in shaping behavioural intentions. Individuals would be more willing to engage in socially responsible businesses if they feel empowered to do so. Those with greater financial understanding and access to investment possibilities, for example, are more likely to indicate a desire to participate in SRI (Pick-Soon et al., 2024).

5. Limitations and Recommendations for Future Researchers

The current study on SRI intentions among Sri Lankan undergraduates has its own limitations, including the purposive sample, and its cross-sectional strategy. The survey was limited to Business undergraduates, which may not represent opinions of other undergraduates. Future research should focus on comparisons between different socio-cultural and educational cohorts to understand cultural and educational influences on SRI intentions. This could help develop tailored educational programs to raise awareness and encourage greater participation in SRI.

6. Conclusion

The study reveals a significant lack of awareness of Socially Responsible Investment (SRI) among Sri Lankan Business undergraduates, with only 42.9% of respondents being aware of SRI. This highlights the need for educational programs to increase awareness of SRI and presents a strategic opportunity for universities, politicians, and companies to launch more effective SRI education and outreach programs. Sri Lanka's low exposure to SRI may be due to traditional profit-driven investment techniques, which may prioritize financial rewards over social or environmental implications. Corporations can play a crucial role in promoting SRI by emphasizing the social and environmental benefits of their business practices. Companies should promote transparency by publishing full reports on their SRI initiatives and encouraging investors to support ethical ventures. Politicians can use this data to encourage SRI through government laws and programs, providing tax breaks or financial incentives to encourage larger participation in SRI.

The findings of the study would benefit managers, policymakers, investors, and companies by providing a guideline for understanding the factors affecting SRI intention and providing insights for investors. This information could be used to enhance investment decisions and portfolios, and for fund or investment companies to understand why investors choose SRI over conventional investments. This information would assist in launching suitable social responsibility funds or green financing products, and help companies attract more investors.

REFERENCES

Adam, A. A., & Shauki, E. R. (2014). Socially responsible investment in Malaysia: behavioral framework in evaluating investors' decision-making process. Journal of Cleaner Production, 80, 224–240. https://doi.org/https://doi.org/10.1016/j.jclepro.2014.05.075

Ajzen, I. (1971). Attitudinal vs. Normative Messages: an investigation of the differential effects of persuasive communications on behavior. Sociometry, 34(2), 263. https://doi.org/10.2307/2786416

Ajzen, I. (1991). The Theory of Planned Behaviour. Organizational Behaviour and Human Decision Processes, 50, 179–211. https://doi.org/10.1080/10410236.2018.1493416

Ajzen, I. (2006). Constructing a Theory of Planned Behavior Questionnaire.

Ajzen, I., & Fishbein, M. (1969). The prediction of behavioral intentions in a choice situation. Journal of Experimental Social Psychology, 5(4), 400–416. https://doi.org/https://doi.org/10.1016/0022-1031(69)90033-X

Al Mamun, A., Mohamad, M. R., Yaacob, M. R. Bin, & Mohiuddin, M. (2018). Intention and behavior towards green consumption among low-income households. Journal of Environmental Management, 227, 73–86. https://doi.org/10.1016/j.jenvman.2018.08.061

Albayrak, T., Aksoy, Ş., & Caber, M. (2013). The effect of environmental concern and scepticism on green purchase behaviour. Marketing Intelligence and Planning, 31(1), 27–39. https://doi.org/10.1108/02634501311292902

Arli, D., Tan, L. P., Tjiptono, F., & Yang, L. (2018). Exploring consumers' purchase intention towards green products in an emerging market: The role of consumers' perceived readiness. International Journal of Consumer Studies, 42(4), 389–401. https://doi.org/10.1111/ijcs.12432

Arslan, M., & Şar, S. (2018). Examination of environmentally friendly "green" logistics behavior of managers in the pharmaceutical sector using the Theory of Planned Behavior. Research in Social and Administrative Pharmacy, 14(11), 1007–1014. https://doi.org/10.1016/j.sapharm.2017.12.002

Belgiawan, P. F., Schmöcker, J. D., Abou-Zeid, M., Walker, J., & Fujii, S. (2017). Modelling social norms: Case study of students' car purchase intentions. Travel Behaviour and Society, 7, 12–25. https://doi.org/10.1016/j.tbs.2016.11.003

Bodie, Z., Kane, A., & Marcus, A. J. (2018). Investments (11th ed.). McGraw-Hill Education.

Borsboom, D., Mellenbergh, G. J., & Van Heerden, J. (2003). The theoretical status of latent variables. Psychological Review, 110(2), 203–219. https://doi.org/10.1037/0033-295X.110.2.203

Central Bank of Sri Lanka. (2022). Overview Financial Sector Performance and System Stability.

Dilla, W., Janvrin, D., Perkins, J., & Raschke, J. (2016). Investor views, investment screen use, and socially responsible investment behavior. Sustainability Accounting, Management and Policy Journal, 7(2), 246–267. https://doi.org/10.1108/SAMPJ-07-2015-0066

Dilrukshi, R. M. D. N. (2022). CSR disclosure and financial performance in listed manufacturing companies in Sri Lanka. International Journal of Accountancy, 2(2), 72. https://doi.org/10.4038/ija.v2i2.45

Economic and social commission for Asia and the Pacific. (2023, August 23). Accelerating Sustainable Finance Through Private Sector Participation in Sri Lanka. ESCAP.

Grilli, G., & Notaro, S. (2019). Exploring the influence of an extended theory of planned

behaviour on preferences and willingness to pay for participatory natural resources management. Journal of Environmental Management, 232, 902–909. https://doi.org/https://doi.org/10.1016/j.jenvman.2018.11.103

Hair, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2014). A Primer on Partial Least Squares Structural Equation Modeling. In Long Range Planning (Vol. 46, Issues 1–2). SAGE Publications, Inc. https://doi.org/10.1016/j.lrp.2013.01.002

Hair, J. F., Risher, J. J., Sarstedt, M., & Ringle, C. M. (2019). When to use and how to report the results of PLS-SEM. European Business Review, 31(1), 2–24. https://doi.org/10.1108/EBR-11-2018-0203

Heinkel, R., Kraus, A., & Zechner, J. (2001). The effect of green investment on corporate behavior. The Journal of Financial and Quantitative Analysis, 36(4), 431–449. https://doi.org/10.2307/2676219

Ilangakoon, A., & Silva, A. (2024, November 7). The impact of unethical practices of Quantity Surveyors on sustainable development in the Sri Lankan construction industry. Conference Proceedings of Institute of Quantity Surveyors Sri Lanka Annual Technical Sessions 2024.

Jonwall, R., Gupta, S., & Pahuja, S. (2023). A comparison of investment behavior, attitudes, and demographics of socially responsible and conventional investors in India. Social Responsibility Journal, 19(6), 1123–1141. https://doi.org/10.1108/SRJ-08-2021-0358

Judge, M., Warren-Myers, G., & Paladino, A. (2019). Using the theory of planned behaviour to predict intentions to purchase sustainable housing. Journal of Cleaner Production, 215, 259–267. https://doi.org/https://doi.org/10.1016/j.jclepro.2019.01.029

Krejcie, R. V, & Morgan, D. W. (1970). Determining sample size for research activities. Educational and Psychological Measurement, 30, 607–610.

Kumar, A., & Basu, R. (2023). Do eco-labels trigger green product purchase intention among emerging market consumers? Journal of Indian Business Research, 15(3), 466–492. https://doi.org/10.1108/JIBR-09-2022-0248

Kumari, D. A. T. (2020). The impact of financial literacy on investment decisions: with special reference to undergraduates in Western Province, Sri Lanka. Asian Journal of Contemporary Education, 4(2), 110–126. https://doi.org/10.18488/journal.137.2020.42.110.126

Lewis, A., & Mackenzie, C. (2000). Morals, money, ethical investing and economic psychology. Human Relations, 53(2), 179–191. https://doi.org/10.1177/a010699

Madhavika, W. D. N., Amaraweera, D. I., Fernando, M. S. A., Perera, K. K. D. H., & Perera, M. N. D. (2021). factors influencing the green purchase intentions of consumers in event

planning industry in Sri Lanka. SLIIT Business Review, 01(02), 1–24. https://doi.org/10.54389/KGHP3940

Marti, E., Fuchs, M., DesJardine, M. R., Slager, R., & Gond, J. P. (2024). The impact of sustainable investing: A multidisciplinary review. Journal of Management Studies, 61(5), 2181–2211. https://doi.org/10.1111/joms.12957

Oehmke, M., & Opp, M. M. (2024). A Theory of Socially Responsible Investment. Review of Economic Studies. https://doi.org/10.1093/restud/rdae048

Park, E., & Ohm, J. Y. (2014). Factors influencing the public intention to use renewable energy technologies in South Korea: Effects of the Fukushima nuclear accident. Energy Policy, 65, 198–211. https://doi.org/https://doi.org/10.1016/j.enpol.2013.10.037

Pienitz, R., & Vincent, W. F. (2000). Effect of climate change relative to ozone depletion on UV exposure in subarctic lakes. Nature, 404(6777), 484–487. https://doi.org/10.1038/35006616

Ratu Balqis Malzara, V., Widyastuti, U., & Dharmawan Buchdadi, A. (2023). Analysis of Gen Z's green investment intention: The application of theory of planned behavior. Jurnal Dinamika Manajemen Dan Bisnis, 6(2). http://journal.unj.ac.id/unj/index.php/jdmb

Raut, R. K., Kumar, R., & Das, N. (2020a). Individual investors' intention towards SRI in India: an implementation of the theory of reasoned action. Social Responsibility Journal, 17(7), 877–896. https://doi.org/10.1108/SRJ-02-2018-0052

Raut, R. K., Kumar, R., & Das, N. (2020b). Individual investors' intention towards SRI in India: an implementation of the theory of reasoned action. Social Responsibility Journal, 17(7), 877–896. https://doi.org/10.1108/SRJ-02-2018-0052

Richardson, B. J. (2008). Socially Responsible Investment Law: Regulating the Unseen Polluters. Oxford University Press. https://doi.org/10.1093/acprof:oso/9780195333459.001.0001

Rossiter, J. R. (2002). The C-OAR-SE procedure for scale development in marketing: A comment. International Journal of Research in Marketing, 19(4), 1–31. https://doi.org/10.1016/j.ijresmar.2003.08.002

Sandberg, J., Juravle, C., Hedesström, T. M., & Hamilton, I. (2009). The heterogeneity of socially responsible investment. Journal of Business Ethics, 87(4), 519–533. https://doi.org/10.1007/s10551-008-9956-0

Singh, M., Mittal, M., Mehta, P., & Singla, H. (2021). Personal values as drivers of socially responsible investments: a moderation analysis. Review of Behavioral Finance, 13(5), 543–565. https://doi.org/10.1108/RBF-04-2020-0066

Sparkes, R., & Cowton, C. J. (2004). The maturing of socially responsible investment: A review

of the developing link with corporate social responsibility. Journal of Business Ethics, 52(1), 45–57. https://doi.org/10.1023/B:BUSI.0000033106.43260.99

Swarnapali, R. N. C. (2019a). Sustainability disclosure and earnings informativeness: evidence from Sri Lanka. Asian Journal of Accounting Research, 5(1), 33–46. https://doi.org/10.1108/AJAR-05-2019-0033

Thanki, H., Shah, S., Rathod, H. S., Oza, A. D., & Burduhos-Nergis, D. D. (2022). I am ready to invest in socially responsible investments (SRI) options only if the returns are not compromised: Individual investors' intentions toward SRI. Sustainability (Switzerland), 14(18). https://doi.org/10.3390/su141811377

The Asia Foundation. (n.d.). The Asia Foundation Addressing Industrial Pollution Along the Kelani River. Retrieved September 11, 2024, from: Addressing Industrial Pollution Along the Kelani River - The Asia Foundation

Verma, V. K., & Chandra, B. (2018). An application of theory of planned behavior to predict young Indian consumers' green hotel visit intention. Journal of Cleaner Production, 172, 1152–1162. https://doi.org/https://doi.org/10.1016/j.jclepro.2017.10.047

Wang, C., Zhang, J., Yu, P., & Hu, H. (2018). The theory of planned behavior as a model for understanding tourists' responsible environmental behaviors: The moderating role of environmental interpretations. Journal of Cleaner Production, 194. https://doi.org/10.1016/j.jclepro.2018.05.171

Wijayasinghe, C. (2023). Influence of green practices on financial performance: A review of high-polluting firms in Sri Lanka. 9, 27–45.

Wijesekara, S. S. R. M. D. H. R., Mayakaduwa, S. S., Siriwardana, A. R., de Silva, N., Basnayake, B. F. A., Kawamoto, K., & Vithanage, M. (2014). Fate and transport of pollutants through a municipal solid waste landfill leachate in Sri Lanka. Environmental Earth Sciences, 72(5), 1707–1719. https://doi.org/10.1007/s12665-014-3075-2

Wijesinghe, K. N. (2012). Current context of disclosure of corporate social responsibility in Sri Lanka. Procedia Economics and Finance, 2, 171–178. https://doi.org/10.1016/s2212-5671(12)00077-9

World Commission on Environment and Development. (1987). Report of the World Commission on Environment and Development: Our Common Future Towards Sustainable Development.

Yee, C. H., Al-Mulali, U., & Ling, G. M. (2022). Intention towards renewable energy investments in Malaysia: extending theory of planned behaviour. Environmental Science and Pollution Research, 29(1), 1021–1036. https://doi.org/10.1007/s11356-021-15737-x

Zhang, X., & Huang, C. H. (2024). Investor characteristics, intention toward socially responsible

investment (SRI), and SRI behavior in Chinese stock market: The moderating role of risk propensity. Heliyon, 10(14). https://doi.org/10.1016/j.heliyon.2024.e34230

EN ROUTE TO ACHIEVE ZERO DEATHS DUE TO DEHYDRATION IN CHILDREN: KNOWLEDGE, ATTITUDES AND PRACTICES ON ORAL REHYDRATION SOLUTION AMONG THE CAREGIVERS OF INPATIENT CHILDREN IN TWO TERTIARY PAEDIATRIC UNITS

THUSTHIKA A[1], KUDAGAMMANA S T[2]

[1]*Department of Health Sciences*, *Faculty of Science*,

NSBM Green University, Sri Lanka

[2]*Department of Pediatrics*, *Faculty of Medicine*,

University of Peradeniya, Sri Lanka

[1]thusthika.a@nsbm.ac.lk, [2]sanathushara@yahoo.com

Abstract

This cross-sectional study aimed to assess the knowledge, attitudes, and practices regarding Oral Rehydration Solution (ORS) usage among 316 caregivers of children to two tertiary paediatric units in Sri Lanka. The mean age of participants was 34.74 years, with 88.9% being mothers. Majority were Sinhalese (66.8%), from urban areas (65.2%), and had completed education up to ordinary level (38.6%). Although 98.1% had heard of ORS, only 61.3% had received health education on its use, primarily from medical officers (60.3%). Caregivers' awareness of ORS components and its correct purposes was inadequate, with misconceptions such as ORS stopping diarrhoea (42.1%). Only 49% knew to start ORS after the first or second episode of watery stools. A majority (70.9%) understood the importance of using prepared ORS within 24 hours, but misconceptions regarding over-administration were prevalent. Positive attitudes towards ORS usage were observed in 80.7% of caregivers, particularly among those in urban areas and employed individuals. Despite this, practices varied, with 70.6% demonstrating good practices. Most caregivers (67.4%) always washed hands before preparing ORS, and 62% correctly followed preparation guidelines. However, only 29.4% kept ORS sachets at home, and 81.6% never prepared homemade ORS in the absence of sachets. Findings highlight significant gaps in knowledge and practices despite generally positive attitudes. Misconceptions regarding ORS purposes and administration require targeted health education interventions.

Enhancing caregiver knowledge and promoting correct ORS practices could reduce child morbidity and mortality related to diarrhoea. Addressing these gaps through structured programs remains imperative.

Keywords: Attitude, Oral Rehydration Solution, Gastroenteritis, Knowledge, Practices

1. Introduction

Acute gastroenteritis, an inflammation of the mucous membranes lining the gastrointestinal system, is often associated with vomiting and/or diarrhoea (Webb & Starr, 2005).

Diarrhoea is defined as the passage of three or more loose or watery stools within 24 hours and is the most common clinical manifestation of gastrointestinal infections. These infections are caused by pathogens typically transmitted from person to person through the fecal-oral route, meaning the infective agent enters food from an infected person's feces. In children, acute diarrhoea has three main forms: acute watery diarrhoea, bloody diarrhoea, and persistent diarrhoea (UNICEF and WHO, 2009).

Acute watery diarrhoea is associated with significant dehydration due to fluid loss and usually lasts from hours to days. Bloody diarrhoea, also known as dysentery, involves the presence of blood in loose stools and is caused by bacteria or parasites, such as Entamoeba species. Persistent diarrhoea is characterized by diarrhoea lasting more than 14 days (UNICEF and WHO, 2009).

Each year, approximately 2.5 billion cases of diarrhoea are reported among children under five, a statistic that has remained consistent over the past two decades. The incidence of these cases varies depending on the child's age and the seasonality of the region. Mortality from diarrhoea in children under five has decreased from 5 million to 1.5 million as of 2004. Despite this reduction, diarrhoea remains the second leading cause of childhood mortality worldwide. Countries in Africa and Southeast Asia account for more than 80% of diarrhoea-related deaths among children under five. Approximately 75% of these deaths occur in 15 countries, including India, Nigeria, the Democratic Republic of Congo, Afghanistan, Ethiopia, Pakistan, Bangladesh, China, Uganda, Kenya, Niger, Burkina Faso, Tanzania, Mali, and Angola (UNICEF and WHO, 2009).

In 1983, following the launch of the Diarrhoeal Disease Control program in Sri Lanka, there was a marked decline in infant and child mortality from diarrhoeal diseases. Although diarrhoea was the leading cause of child death in 1983, the mortality rate had dropped to 2% of all deaths among children in this age group by 1996. However, the incidence of diarrhoeal cases remained stable between 1983 and 1998 (Sonnadara, 2000).

In 2014, deaths from diarrhoea accounted for approximately 1.3% of all child deaths in Sri Lanka (Fernando et al., 2014). While this may seem minor, most of these deaths occurred in otherwise healthy children and were preventable. According to the Ministry of Health's weekly epidemiological report on rotavirus surveillance, although diarrhoea-related mortality has decreased over the past two decades, incidence rates have not shown a similar decline. The hospital admission rate due to diarrhoea ranged from 676.1 to 961.3 per 100,000 admissions during this period, making it the sixth leading cause of hospital admission according to Sri Lanka's indoor morbidity and mortality data (Sri Lanka: epidemiological unit, 2020).

According to the 2017 Annual Health Bulletin published by the Ministry of Health and Indigenous Medical Services in Sri Lanka, diarrhoeal disease accounted for approximately 5–10% of deaths in children under five (Ministry of Health and Indigenous Medical Services, 2017).

The physiological concept of dehydration is based on the balance between fluid secretion and reabsorption of electrolytes in the gastrointestinal tract. During diarrhoeal disease, this balance is disrupted as increased intestinal output exceeds the absorptive capacity of the intestinal epithelium, leading to dehydration (King et al., 2003).

The primary reason for the hospitalization of children with acute gastroenteritis is moderate to severe dehydration, although mild dehydration, influenced by social factors, can also lead to admissions (Hoxha et al., 2014). The objectives of treating diarrhoeal disease are to prevent and manage dehydration while also providing symptomatic relief (Hartman et al., 2019). Accurate assessment of dehydration is crucial, as both overestimation and underestimation can result in inadequate care, leading to increased morbidity and mortality (Duhamel et al., 2013; Hoxha et al., 2014). Mild dehydration may be overlooked in clinical evaluations, but it becomes more

evident in cases of moderate to severe dehydration (≥5%) (Brewster, 2002, Duhamel et al., 2013).

Clinical manifestations of dehydration become apparent in a child after they lose about 5% of their body weight (Elliott, 2007). Several scales have been developed to assess dehydration in children, with the most widely accepted being the Children Dehydration Scale. This scale helps determine the length of hospital stay and the need for intravenous fluid therapy (Duhamel et al., 2013).

Mild dehydration can be treated with ORS at home. In cases of mild to moderate dehydration, medications are often needed to reduce vomiting and improve tolerance to ORS. Severe dehydration requires emergency medical care, including intravenous rehydration (Hartman et al., 2019; King et al., 2003). There are six key concepts in managing dehydration caused by diarrhoea in children, (Churgay & Clinic, 2012; King et al., 2003) which are outlined as;

1. Administered ORS within 3 to 4 hours of onset of symptoms.
2. Usual diet of the child must be given once dehydration is treated.
3. Breastfeeding should be carried on in nursing children.
4. For the children who are formula feed, the formula need not be diluted, and they need not be given extra formulas.
5. Extra ORS should be given to supplement loss due to diarrhoea.
6. Additional medications and tests should be avoided.

ORS plays a crucial role in the management of diarrhoeal diseases caused by various etiological agents in the home setting. Treatment can begin at home as soon as a child shows signs of illness or dehydration. Prompt assessment and the administration of ORS can prevent or reduce complications such as dehydration, poor nutritional status, hospital visits, and admissions (King et al., 2003).

ORS was initially introduced in 1969 by UNICEF and WHO as the drug essential for the management of dehydration in the world. For the advancement of the strength of ORS in the hot and humid country, the ingredient sodium bicarbonate was replaced by the trisodium citrate, and a new formulation was introduced in 1984. From that point of time, for more than 20 years WHO and UNICEF encouraged this formula of ORS to treat diarrhoea of all age and cause of origin. This has reduced death rate of diarrhoeal

disease worldwide. A reduced osmolality ORS formula was developed after many studies (UNICEF and WHO, 2009).

Sri Lanka boasts a literacy rate of 95.7% in 2012 and exhibits particularly favorable health indicators compared to similar countries. The country also has a robust healthcare system, with 31 family health workers and 91 medical officers per 100,000 population in 2018. Most people have access to a hospital staffed by qualified doctors within a short period of time (Medical statistics unit, 2018). However, despite this strong healthcare framework, diarrhoea still accounts for 3.2% of deaths in children under five years of age in Sri Lanka. The impact of diarrhoeal disease can be significantly reduced through appropriate and timely treatment with ORS (Karthijekan et al., 2017).

A study conducted 17 years ago identified a major hindrance to achieving the goal of preventing and treating dehydration due to diarrhoea using ORS: the lack of caregiver knowledge about diarrhoea and the proper use of ORS (Seneviratne, 2003).

While the effectiveness of ORS is well-documented, its benefits are contingent on how it is used in specific situations. This, in turn, depends on the caregiver's knowledge and attitude towards ORS. Considering this, the present study was conducted to assess the knowledge, attitudes, and practices of mothers of children admitted to two tertiary paediatric units regarding the management of dehydration caused by acute gastroenteritis using ORS. By identifying knowledge gaps and the reasons for suboptimal use of ORS in managing patients with acute gastroenteritis, this study aims to provide valuable insights. Additionally, the findings could be beneficial for future research and the development of health-related policies. Despite its importance, very few studies have been conducted on this topic in recent years within the country.

2. Literature Review

A cross-sectional study was undertaken under the topic, “Mother’s awareness regarding the administration of oral rehydration solution among children suffering from acute diarrhoea” at Sir Ganga Ram Hospital, Lahore from February to May 2018. In conclusion of this study, it revealed that knowledge about oral rehydration solution and its effectiveness in treating diarrhoea was adequate. However, there was an apparent lack of knowledge in administration of ORS, home management of the diarrhoea and the compositions of the ORS. This study emphasized to increase parental or caregiver

knowledge of the usage, preparations and the administration of the ORS to treat diarrhoea (Qadeer et al., 2020).

From 1st June to 31st December 2019, a descriptive cross-sectional hospital-based study was undertaken in two major paediatric hospitals in Omdurman locality, Khartoum, Sudan: Muhammad Alamin Hamid children emergency hospital and Al-Bulok specialise children hospital. Out of 222 mothers of children under five years enrolled in the study, 198 were assessed through a semi-structured questionnaire. This showed that, although the knowledge about ORS was satisfactory good among mothers, most of them didn't use it or prepare it in an appropriate manner. When considering dehydration, mothers were able to detect signs and symptoms of dehydration, but they unable to classify it according to severity. Through this study, it was identified that there was a misleading attitude of seeing medical advice such as over the counter drug to treat dehydration. It was recommended by the researchers of this study to upgrade perceptions of mothers about usage and correct way for preparation of ORS and keep away from administering medication without medical advice (Mohamed & Mohammed, 2020).

There was another observational cross-sectional study was carried out in the Department of Paediatrics, Cantonment General Hospital, Rawalpindi, Pakistan. About 400 mothers who visited outpatient department of the hospital were assessed by administering validated questionnaire. Mother's knowledge and awareness about ORS were assessed. In conclusion of the study, it was illustrated that in purpose, administration and initiations of ORS mothers had a high awareness level. But there was a gap of knowledge in correct timing of ORS in home management to treat diarrhoea in children by mothers (Noshina Riaz et al., 2019).

From February to March 2018, a community based cross sectional study at Dangure, a district of Benishagule Gumuz Regional State, Northwest Ethiopia was undertaken to assess the prevalence of ORS and elements related among the children of age under five with diarrhoea. Through this study it was concluded that elements affecting the ORS use in the management of the diarrhoea were educational qualifications of the participants, income of the family, comprehension on the ORS, the earlier occurrence and treatment done previously (Misgna et al., 2019).

There was a cross-sectional descriptive study undertaken in a field area near to the medical college in Kanchipuram, India. This study concluded that most of the mothers had sufficient knowledge, attitudes and practices towards ORS. But their knowledge, attitudes and practices about management of diarrhoeal disease by ORS seemed to be insufficient and needed to be addressed (Muthulakshmi & Gopalakrishnan, 2017).

A descriptive cross-sectional study was conducted among mothers of children aged under five living in 5 MOH areas in Batticaloa, Eastern province, Sri Lanka. In the summary of the research, especially considering the knowledge regarding management of diarrhoea by oral rehydration solution, it was revealed that in spite the existence of highest level of understanding about ORS only two-third was aware of its correct preparations. And knowledge attitudes and practices about correct preparation of sugar salt solution was inadequate among mothers. This study emphasized on the importance of need of health care facility involvement to increase the awareness about ORS/SSS to prevent dehydration in diarrhoeal disease among children (Karthijekan et al., 2017).

There was another descriptive quantitative study done in Katutura, Sri Lanka. It was revealed that participants' knowledge on ORS and dehydration was satisfactory. However, they had poor attitudes on ORS. And some misconceptions about the usage of ORS were illustrated by this study. Most common of them were, diarrhoeal frequency is accelerated by ORS, body salt compositions altered by ORS which leads to oedema. Besides this, practice of ORS was optimum among participants. Although ORS was used by most mothers, only small participants had given ORS according to the instruction on the product. Unsatisfactory practice was noticed on initiation, administration, storage and disposal of ORS (Fernando et al., 2014).

3. General Objective

The General objective of this study is to assess the knowledge, attitudes, and practices among the caregivers of children getting admitted to two tertiary paediatric units towards the use of ORS in the management of dehydration because of acute gastroenteritis. The specific objectives were to evaluate the knowledge among the caregivers of children getting admitted to two tertiary paediatric units towards the use of ORS in the management of dehydration because of acute gastroenteritis , to evaluate the attitudes among the caregivers of children getting admitted to two tertiary paediatric

units towards the use of ORS in the management of dehydration because of acute gastroenteritis and to evaluate practices among the caregivers of children getting admitted to two tertiary paediatric units towards the use of ORS in the management of dehydration because of acute gastroenteritis.

4. Methodology

This was a descriptive cross-sectional and analytical study. Totally 316 participants were recruited during study period. Caregivers of children getting admitted to paediatric medical wards of Sirimavo Bandaranayke Specialized Children Hospital (SBSCH) and professorial paediatric ward of Teaching Hospital Peradeniya, Sri Lanka were included in the study. The sample size was calculated as 316 taking the anticipated population proportion (0.71 since the prevalence of ORS usage in a similar study done in Kaluthara, Sri Lanka is 71%) (Fernando et al., 2014). The Convenient sampling technique was used. Data was collected between the period of January 2021 to April 2022.

A pretested, self-administrated questionnaire was used in preferred language. The questionnaire was pre-tested on 10 caregivers from SBSCH, Peradeniya. The questionnaire had 4 parts - demographic data, knowledge, attitudes, and practices about ORS. Informed written consent was obtained prior to the data collection. Data was analyzed using IBM SPSS version 25. Ethical clearance was obtained from the Ethical Review Committee, Faculty of Allied Health Sciences, University of Peradeniya (AHS/ERC/2021/017). The permission to collect data from the Teaching hospital and SBSCH, Peradeniya was obtained from the Hospital Directors and relevant ward managers.

5. Findings

5.1 Socio demographic characteristics

Totally 316 caregivers were recruited during the study period. The mean age of the caregivers was 34.74 (± 7.172) years. And 88.9% were mothers (284) among them more than 50% were between age 31 to 40 years. Out of all recruited in the study, 66.6% were Sinhalese ,14.6% were Tamil and 18.7% were Muslims. The majority had completed education up to ordinary level (38.6%, 122) and only 12% had studied up to Degree level. Out of all 61.4% were unemployed. Most of the caregivers had two children

(45.9%,145) while 26.3% (83) had only one child. 65.2% were from urban areas on the other hand, 9.5% were from estate. The sociodemographic distributions were illustrated in table 1.

Table 5: Respondents' Demographic Profile

Demographic information	Number of caregivers(n)	Percentages (%)
Participants' relationship		
Mother	284	89.9%
Father	24	7.6%
Other (close relation to the child)	8	2.5%
Age of the participants		
21 to 30 years	98	31.0%
31 to 40 years	159	50.3%
41 to 50 years	51	16.1%
51 to 60 years	8	2.5%
Ethnicity		
Sinhala	211	66.8%
Tamil	46	14.6%
Muslim	59	18.7%
Highest educational level		
Not gone to school	8	2.5%
Primary (grade 1 to 5)	11	3.5%
Ordinary level (grade 6 to 11)	122	38.6%
Advanced level (grade 12 to 13)	112	35.4%
Diploma level	25	7.9%
Degree	38	12.0%
Employment status		
No	194	61.4%
Yes	122	38.6%
Number of children in the family including this child		
One	83	26.3%
Two	145	45.9%
More than 2	88	27.8%

5.2 Knowledge about ORS usage

In the group of caregivers responded, 98.1% (310) heard about ORS and around 95.3% had seen ORS packet before. 61.3% of the caregivers had received health education about ORS. Out of them, majority (60.3%) were from the medical officers. It was identified in present that contribution of mass medias such as newspaper (9.8%), television/ radio (14.4%) and social networks (16%) in health education regarding ORS was significantly low. Majority of the participants were aware that dehydration (59.4%)

was the main complication of the gastroenteritis followed by chronic diarrhoea (31.9%), malnutrition (30.3%), and systemic infection (21%). With respect to signs and symptoms of the dehydration, there was a wide variety of choices among the caregivers. Most caregivers went for dry and sticky mouth (55.3%) followed by less or no urination (50.8%), sunken eyes (42.4%), dry and cool skin (31.8%). Least selected was few or no tears while crying (30.9%).

Table 6: Respondents' Knowledge about ORS Usage

Statements		Number (N)	Percentage (%)
The volume of ORS administered depends on age of the child	No	56	17.8%
	Yes	203	64.4%
	Do not know	56	17.8%
Prepared ORS solution must be used before 24 hours of its preparation	No	26	8.2%
	Yes	224	70.9%
	Do not know	66	20.9%
Excessive administrations of ORS cause swelling of body	No	57	18.0%
	Yes	69	21.8%
	Do not know	190	60.1%
Excessive administrations of ORS cause alterations in the salt composition of the body	No	48	15.2%
	Yes	83	26.3%
	Do not know	185	58.5%
The taste of ORS to the child is pleasant	No	60	19.0%
	Yes	172	54.4%
	Do not know	84	26.6%

When discussing the caregivers' awareness about components of the ORS, more than 40% of the caregivers had understanding that sodium chloride/ table salt (49.4%) and glucose (43.4%) were the components of the ORS. While less than 25% of the participants stated potassium (20.9%) and sodium citrate (16.1%) were included in ORS packet.

This study discussed that about 60% participants knew that ORS replaces the water lost in diarrhoea (194,61.4%) meanwhile nearly only 40% of the participants stated that ORS replaces the energy (149,47.2%) and salt (141,44.6%) lost in diarrhoea. More than 30% had incorrect understanding that ORS stops diarrhoea (133,42.1%) and ORS reduces the duration of the diarrhoea (99,31.3%). Nearly half the amount of the caregivers (49%) stated ORS administration should be started soon after first / second

motion of watery stools noticed in children. The responses of the participants to the knowledge questions were illustrated in the table 2.

5.3 Attitudes about ORS usage

Assessing caregivers' attitudes regarding ORS usage is another objective of the current study. In general, 80.7% (255) of the caregivers had positive attitudes in the scale regarding ORS usage while 19.3% (61) had negative attitude.

Table 7: Respondents' Attitudes about ORS Usage

Statements		Number (N)	Percentages (%)
I will use ORS only after getting advice from health care workers.	Strongly disagree	4	1.3%
	Disagree	17	5.4%
	Neutral	22	7.0%
	Agree	99	31.3%
	Strongly agree	174	55.1%
I will continue the usual fluids to child while giving ORS.	Strongly disagree	6	1.9%
	Disagree	51	16.1%
	Neutral	36	11.4%
	Agree	87	27.5%
	Strongly agree	136	43.0%
I will continue breastfeeding the child while giving ORS (if child is a breastfeed child.)	Strongly disagree	7	2.2%
	Disagree	41	13.0%
	Neutral	44	13.9%
	Agree	79	25.0%
	Strongly agree	145	45.9%
I will obtain ORS free from government health care facilities	Strongly disagree	10	3.2%
	Disagree	43	13.6%
	Neutral	88	27.8%
	Agree	86	27.2%
	Strongly agree	89	28.2%
I will bring child to hospital when danger signs of dehydration appear despite giving ORS	Strongly disagree	10	3.2%
	Disagree	25	7.9%
	Neutral	27	8.5%
	Agree	95	30.1%
	Strongly agree	159	50.3%
It is better to use antibiotics than ORS to treat diarrhoea.	Strongly disagree	47	14.9%
	Disagree	62	19.6%
	Neutral	57	18.0%
	Agree	95	30.1%
	Strongly agree	55	17.4%

Out of all the caregivers having negative attitudes, 63.9% from rural area and 75.4% were unemployed. Nearly 85% living in the urban area had positive attitudes while

87.7% of the employed caregivers were having positive attitudes. Responses of the caregivers to the attitude questions were included in the Table 3.

6 Practices Regarding ORS

Nearly 52% of the children recruited had suffered from diarrhoea at least once in past 6 months and among them 62.04 % had been administered ORS by their caregivers. Therefore, the prevalence of ORS usage among the caregivers in past 6 months was 62.04%. Totally 12 questions were included in the questionnaire to assess the practices of the caregivers towards ORS usage. Each question was scored from 1 to 4 according to a Likert scale. The total score for each participant were calculated between 12 to 48. And they were categorized as having poor and good practices according to the median score. Accordingly, 29.4% had poor while 70.6 % had good practices in ORS usage.

Most of the caregivers always took child to hospital when she/he got diarrhoea (186, 58.9%). Out of all caregivers 51.3% (162) never gave ORS to child without getting advice from the health care services. Only 15.5% (49) had always given their children ORS without getting medical advice. Most of the caregivers had always read all information ORS packet before preparing it (46.2%,146). About 30.1% (95) had always commenced ORS administration after passage of loose stools more than two times in the child and 29.1% (92) had never commenced ORS administration after passage of loose stools more than two times in the child. Among them 63% (58) were unemployed. Majority of caregivers had always prepared the ORS solution correctly after reading instruction on the packet itself (62.0%, 196) and had always washed their hands before preparing the ORS (67.4%,213). Only 29.4% (93) always had ORS packets on home although their children do not have diarrhoea.

Majority of the caregivers had always used boiled cool water to prepare ORS (68%, 215), had always stored ORS in room temperature (53.5%,169) and had always discarded ORS after 24 hours of its preparation (63.9%, 202). Nearly 81.6% (258) of the caregivers had never prepared ORS at home when ORS sachet was not available and only 6.3% (20) had always prepared ORS at home when ORS sachet was not available.

7 Discussion

In the group of caregivers responded, 98.1% (310) heard about ORS before and it was apparently high amount when compared to a result of a similar study done in Sri Lanka where 95% of the participants heard about ORS (Fernando et al., 2014). Around 95.3% had seen ORS packet before and which is less than the amount (97.6%) revealed in a previous study done in Batticaloa district Sri Lanka and a study done in India (99%) (Karthijekan et al., 2017; Muthulakshmi & Gopalakrishnan, 2017).

In the current study, majority (60.3%) responded that medical officers were their main source of information which is similar response in a previous study done in Sri Lanka (Seneviratne, 2003). The caregivers' awareness about components of the ORS, was inadequate. In a similar research study, 87.3% participants knew the components of ORS such as water, salt, and sugar although their knowledge about preparation of the ORS were 44.7 (Agbolade et al., 2015). It suggests the development of appropriate intervention to improve knowledge on the composition of the ORS.

When discussing the knowledge about the purposes of ORS, these numbers are comparably very higher with the result of a Pakistan study, where 6.3% of the participants stated ORS stop diarrhoea and 3% participants stated ORS reduce the duration of the diarrhoea (Noshina Riaz et al., 2019). Another study carried out in West Africa also illustrated 58% of the participants had wrong perception that ORS stop diarrhoea (Digre et al., 2016) and that was supported by another study where (39.8%) caregivers stated that ORS is used for decreasing diarrhoea (Misgna et al., 2019). Therefore, it is necessary to address this important part.

When discussing the initiation of ORS, the numbers reported in this study was low when compared with a study where 68% participants stated same time of initiation of administration of ORS (Noshina Riaz et al., 2019). In the current study 64.4% (203) caregivers aware that quantity of ORS to be administered depends on the age of the children and a similar study also disclosed 60% were aware of correct amount of ORS to begiven to the child (Rani, 2016). Out of all, 70.9% (224) participants agreed that prepared ORS must be used before 24 hours of its preparation. It is significantly the highest percentage when compared to result of similar study done in India where only 42% mothers knew that prepared ORS should not be stored beyond 24 hours

(Muthulakshmi & Gopalakrishnan, 2017). Most of the caregivers of the current study, do not know whether ORS causes side-effects such as swelling of the body (190, 60.1%) or cause alterations in the salt composition of the body (185,58.5%). Majority of the caregivers strongly agreed (174,55.1%) or agreed (99,31.3%) that they would start ORS administration after getting advice from the health care workers on the other hand, only 6.7% stated that they will start ORS without getting advice from health care workers out of them, majority (71.4%) were having positive attitudes in the scale regarding ORS usage. This is more similar with the outcome of study carried out by (Olson et al., 2011) that illustrated that before seeking care from health providers, most positive attitudes caregivers gave a form of ORS during initial home management.

In a study of Sri Lanka 58% of the participants stated, to start ORS administration, physician prescription is needed (Fernando et al., 2014). This is low when compared to the current study. And this attitude among the caregivers may be due to misconceptions revealed by a study done in India, New Delhi which showed the main misconceptions among the participants were, one needs a prescription of a doctor to initiate the ORS administration (Rasania et al., 2005). In the current study almost most of the caregivers had positive attitudes to give usual fluids (223,70.5%) and continue breastfeeding during the administration of ORS (224,70.9%). Only 18% and 15.2% disagreed to those statements, respectively. But two more studies exemplified, 82.6% mothers continue breastfeeding while giving ORS (Masiha et al., 2015) and 98% thought breast feeding should be continued when child is on ORS therapy (Muthulakshmi & Gopalakrishnan, 2017). In another study done by (Agbolade et al., 2015), 86% of participants agreed that ORS should be given with other food while 6.2% disagree. When compared to this study, the caregivers of current studies have inadequate positive attitude in this aspect. This could be due to social cultural differences.

A local study in Sri Lanka concluded 20% stated that medications is better than giving ORS to treat diarrhoea (Fernando et al., 2014) while contrasting to those findings, our current study clearly highlighted that 47.5% (150) agreed or strongly agreed that antibiotics are better than ORS to treat diarrhoea and only (109) 34.5% disagreed or strongly disagreed to the above statement. It is illustrated that usage of ORS among the caregivers is 62.04 %. But a local study done by (Fernando et al., 2014) showed the prevalence of ORS usage was 71% (Fernando et al., 2014). However, in Ethiopia the

prevalence of ORS usage was found to be only 51% (Misgna et al., 2019) but in contrast to this, studies done in India (92%) and West Africa (96%) concluded relatively higher ORS usage (Digre et al., 2016; Muthulakshmi & Gopalakrishnan, 2017). It suggests that intervention could be initiated to encourage the increased use of ORS among the caregivers in Sri Lanka. Totally 67.4% of the participants always washed their hands before preparing ORS which is least number compared to a study where 96% of the mothers washed their hands and vessels before preparing ORS (Muthulakshmi & Gopalakrishnan, 2017). The current study showed 68% always used boiled cool water to prepare ORS while similar studies show nearly 90% participants used boiled cool water to prepare (Fernando et al., 2014; Muthulakshmi & Gopalakrishnan, 2017).

Moreover, in current study, about 53.5% always and 16.5% frequently had stored prepared ORS at room temperature on the other hand 90% had kept ORS at room temperature and the rest stored at refrigerator or had no idea about storage in another study (Fernando et al., 2014). Therefore, comparatively caregivers had poor practices in hand washing, using boiled cool water and storage of ORS in relation to similar studies done locally and out of the country.

Moreover only 29.4% had always ORS packet at home although child does not have diarrhoea, this practice is also revealed in a study as the major barrier in ORS usage in another local similar study (Fernando et al., 2014). According to the study done by Muthulakshmi et. al (Muthulakshmi & Gopalakrishnan, 2017), 82% had prepared home-made ORS when ORS packet was not available at home, while only very least number of caregivers (6.3%) had always did it in the current study. This insists to take necessary actions to educate caregivers about preparing homemade ORS in home setting.

7.1 Limitations and Recommendations for Future Researchers

To address the gaps identified in the study, targeted interventions are recommended to enhance caregivers' knowledge, attitudes, and practices regarding ORS. Educational campaigns should focus on improving understanding of ORS composition and preparation while dispelling misconceptions, such as the belief that antibiotics are superior to ORS for managing diarrhoea. Efforts should be made to increase the accessibility of ORS packets by encouraging caregivers to keep them at home and providing clear instructions for preparing homemade ORS. Additionally, training

sessions should emphasize proper practices, including handwashing, using boiled cooled water, and correct storage of prepared ORS. Healthcare workers should reinforce these messages during consultations to build caregivers' confidence and foster positive attitudes toward ORS usage. Finally, culturally tailored educational materials and community-based programs should address barriers and misconceptions, ensuring widespread adoption of ORS for effective diarrhoea management.

8 Conclusion

In summary, majority of the caregivers were aware of ORS and had seen ORS packet. Major source of information about ORS were medical officers and contribution of the social media (newspaper) on the health education regarding ORS was significantly low. Moreover, this study concluded caregivers had satisfactory knowledge in complications of gastroenteritis, and when to initiate ORS administration. On the other hand, their knowledge on signs and symptoms of dehydration, components of ORS and purposes of ORS may need further improvements. In general, majority of the caregivers had good attitudes towards ORS. The prevalence of ORS usage among the caregivers recruited in the study was 62.04%. It suggested that intervention could be initiated to encourage the use of ORS among the caregivers to further increase ORS use. It is also concluded, comparatively caregivers had poor practices in hand washing, using boiled cool water and storage of ORS in relation to similar studies done locally and out of the country. The practices of preparing ORS at home when ORS packet is not available at home was very poor and this insisted to take necessary actions to educate caregivers about preparing homemade ORS in home setting.

REFERENCES

Agbolade, M. O., Dipeolu, I. O., & Ajuwon, A. J. (2015). Knowledge and use of oral rehydration therapy among mothers of Under-Five children in a military barrack in Ibadan, Nigeria. African Journal of Biomedical Research, 18(1), 7–15. https://doi.org/10.4314/ajbr.v18i1

Brewster, D. (2002). Dehydration in acute gastroenteritis. Journal Paediatric. Child Health, 38, 219–222.

Churgay, C. A., & Clinic, H. M. (2012). Gastroenteritis in Children: Part II. Prevention and Management. American Family Physician, 85(11), 1066–1070.

Digre, P., Simpson, E., Cali, S., Lartey, B., Moodley, M., & Diop, N. (2016). Caregiver perceptions and utilization of oral rehydration solution and other treatments for diarrhoea among young children in Burkina Faso. Journal of Global Health, 6(2), 1–11. https://doi.org/10.7189/jogh.06.020407

Duhamel, A., Pruvost, I., Chazard, E., & Martinot, A. (2013). The Value of Body Weight Measurement to Assess Dehydration in Children. PLOS One, 8(1), 4–9. https://doi.org/10.1371/journal.pone.0055063

Elliott, E. J. (2007). Clinical Review Acute gastroenteritis in children. British Medical Journal, 334, 35–40.

Fernando, T. T. D. D., Tharanganie, S.D.N. Subasinghe, S.M.C.J. Pathirana, K.P.S.D. Ramachandra, R. B. B. S., Senadheera, A. S. P. L., & Priyanthi, W. N. (2014). Knowledge, Attitudes and Practices on Oral Rehydration Salt Solution for Diarrhoea among Mothers with Children under Five Years Old. 15th Open University Research Sessions, 295–300.

Hartman, S., Brown, E., Loomis, E., & Russell, H. A. (2019). Gastroenteritis in Children. American Family Physician, 99(3), 159–165.

Hoxha, T. F., Azemi, M., Avdiu, M., Ismaili-jaha, V., & Grajqevci, V. (2014). The Usefulness of Clinical and Laboratory Parameters for Predicting Severity of Dehydration in Children with Acute Gastroenteritis. Med Arh, 68(11), 304–307. https://doi.org/10.5455/medarh.2014.68.304-307

Karthijekan, K., Namassevayam, G., & Thayabaran, M. (2017). Knowledge Regarding Childhood Diarrhoea and its Management among Mothers Having Children Under the Age of Five Years. Research Gate, 1(August 2018), 1–15.

King, C. K., Glass, R., Bresee, J. S., & Duggan, C. (2003). Managing Acute Gastroenteritis Among Children. In Mortality Morbidity Weekly Report (Vol. 52, Issue 16).

Masiha, S. A., Khalid, A., Malik, B., Muhammad, S., & Shah, A. (2015). Oral Rehydration Therapy- Knowledge, Attitude and Practice Survey of Pakistani Mothers. Journal of Rawalpindi Medical College Students Supplement, 19(s-1), 51–54.

Medical statistics unit, (2018). Annual Health Statistics, Sri Lanka.

Ministry of Health and Indigenous Medical Services. (2017). Annual Health Bulletin, Sri Lanka.

Misgna, G., Ebessa, B., & Kassa, M. (2019). Prevalence of oral rehydration therapy use and associated factors among under-five children with diarrhoea in Dangure, Benishangul Gumuz Region, Ethiopia. BMC Research Notes, 12(1), 1–6. https://doi.org/10.1186/s13104-019-4078

Mohamed, H., & Mohammed, F. (2020). Awareness and attitude towards dehydration and its management amongst mothers and factors influence on in under-five children of Omdurman locality, Sudan. Sudanese Journal of Paediatric, 20(2), 136–143. https://doi.org/10.24911/sjp.106-1585043373

Muthulakshmi, M., & Gopalakrishnan, S. (2017). Use of oral rehydration solution by mothers of under-five children in a rural area of Kancheepuram district, Tamil Nadu: a KAP study. International Journal of Community Medicine and Public Health, 4(11), 4326. https://doi.org/10.18203/2394-6040.ijcmph20174853

Noshina Riaz, Sidra Tul Muntaha, Maria Qibtia, & Shugufta Sohail. (2019). Use of Zinc and Oral Rehydration Solution in Home Management of Diarrhoea: Knowledge of Mothers of attending a Tertiary Care Hospital. Journal of Islamabad Medical & Dental College, 8(3), 135–140. https://doi.org/10.35787/jimdc.v8i3.419

Olson, C. K., Blum, L. S., Patel, K. N., Oria, P. A., Feikin, D. R., Laserson, K. F., Wamae, A. W., Bartlett, A. V, Breiman, R. F., & Ram, P. K. (2011). Community Case Management of Childhood Diarrhoea in a Setting with Declining Use of Oral Rehydration Therapy: Findings from Cross-Sectional Studies among Primary Household Caregivers, Kenya, 2007. 85(6), 1134–1140. https://doi.org/10.4269/ajtmh.2011.11-0178

Qadeer, S., Ahmed Khan, A., Khalid, S., Sharmeen, Z., Hayat, A., & Zahur, M. (2020). The Annals of Research Mother' s awareness regarding the administration of oral rehydration solution among children' s suffering from acute diarrhoea. The Annals of Research, 1(1), 17–23.

Rani, V. P. (2016). Knowledge and Attitude of Mothers about Diarrhoea, ORS and Feeding Practices in Under-Five Children in a Rural Area of Ranga Reddy, Telangana. Journal of Medical Science and Clinical Research, 04(10), 13201–13209. https://doi.org/10.18535/jmscr/v4i10.48

Rasania, S. K., Singh, D., Pathi, S., Matta, S., & Singh, S. (2005). Knowledge and attitude of mothers about oral rehydration solution in few urban slums of Delhi. Health and Population, 28(2), 100–107.

Seneviratne, A. L. P. de S. (2003). A study of maternal awareness of acute diarrhoeal disease. Sri Lanka Journal of Child Health, 32, 66–68.

Sonnadara, D. A. (2000). Management of watery diarrhoea. Sri Lanka Journal of Child Health, 4, 4–5.

Sri Lanka: epidemiological unit. (2020). Weekly epidemiological report (Issue vol.47 No.39). https://doi.org/10.1016/j.cell.2020.08.028

UNICEF and WHO. (2009). Diarrhoea: still dying and what Why children are can be done.

Webb, A., & Starr, M. (2005). Acute gastroenteritis in children. Australian Family Physician, 34(4), 227–231.

A COMPREHENSIVE ANALYSIS AND IMPLEMENTATION OF A PREDICTIVE INVENTORY MANAGEMENT SYSTEM FOR OPTIMIZING BLOOD SUPPLY CHAIN MANAGEMENT: A MACHINE LEARNING APPROACH FOR THE NATIONAL BLOOD TRANSFUSION SERVICE OF SRI LANKA

WEERASINGHE S B[1], RANAWEERA R[2]

[1]*Faculty of Computing*

[2]*Faculty of Postgraduate Studies & Professional Advancement*

NSBM Green University, Sri Lanka

[1]sanuli.w@nsbm.ac.lk, [2]ranaweera.r@nsbm.ac.lk

Abstract

Effective management of blood inventory is critical for ensuring a reliable and efficient supply of whole blood and other blood products across healthcare networks. This study addresses the unique challenges posed by blood supply chain management through a comprehensive analysis and implementation of predictive analytics tailored for the National Blood Transfusion Service (NBTS) of Sri Lanka. A machine learning-based predictive model was developed to forecast monthly demand for the eight blood types, aimed at optimizing inventory levels and minimizing the risks of overstocking and understocking. The model's performance was evaluated using metrics such as Root Mean Square Error (RMSE), Mean Absolute Percentage Error (MAPE), and Coefficient of Determination (R^2). Additionally, this research details the system architecture, model building, and integration process, providing a robust framework for predictive analytics in blood supply chain management. The results underscore the potential of data-driven decision-making in enhancing the operational efficiency of blood inventory management, demonstrating the contribution of Information Technology in Healthcare.

Keywords: Blood Inventory Management, Blood Supply Chain, Decision Tree Regression, Demand Prediction, Machine Learning

1. Introduction

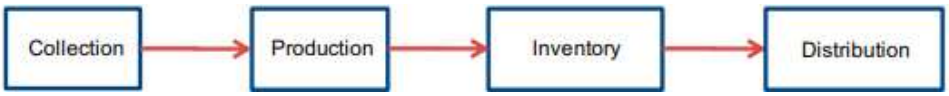
Blood is an essential fluid that is critical for sustaining life, particularly in moments where the body's natural supply is inadequate or impaired. The productiveness of a

healthcare system depends significantly on the availability of a safe and ample blood supply.

The Blood Demand and Supply Chain encompasses the network that oversees the supply and distribution of blood and blood products. This chain can be conceptualized as a complex system comprising four interconnected echelons: Collection, Production, Inventory and Distribution (Chopra & Meindl, 2007). The supply chain begins with voluntary blood donations. Collected blood undergoes processing into whole blood and other blood components (i.e. Red Blood Cells, Platelets and Plasma). Inventory management involves maintaining and controlling suitable stock levels and monitoring expiration. Distribution ensures timely allocation of blood and blood products to the hospital network.

Figure 1: Echelons of Blood Demand & Supply Chain

Source: Chopra & Meindl, 2007



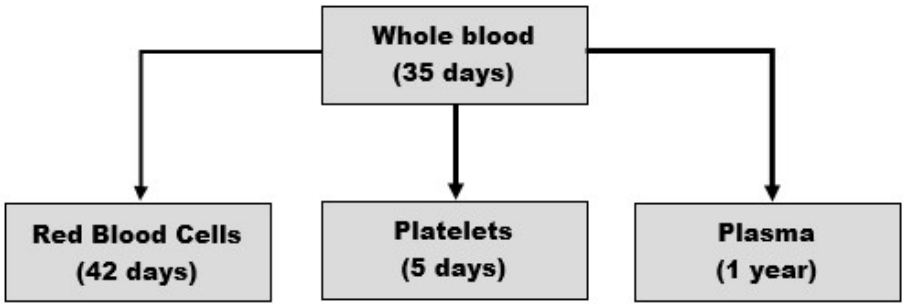
The National Blood Transfusion Service (NBTS) holds the central position in this delicate balance, ensuring a sufficient supply of available blood stocks to meet the national level demand in Sri Lanka. The NBTS offers a range of essential services to facilitate proper inventory and management of blood and blood components.

Despite the role of the NBTS, challenges persist in realizing an optimized Blood Demand & Supply Chain. The equilibrium between supply and demand is often disrupted by the unique complexities introduced by blood inventory management in particular compared to any other inventory management process. The factors such as the perishable nature of blood, criticality of supply, stochastic behavior of the blood demand and supply, and diversity of available blood types, are identified as the main contributors leading to instances of overstocking and understocking.

Unlike many other products, blood has a limited shelf life and must be used within a specific timeframe, creating pressure to ensure that blood products are efficiently utilized before they expire. The Figure 2 summarizes the maximum time period blood and blood products can be typically stored.

Figure 2: Componentization of Blood

Source: Author compiled



This short life span may potentially lead to both overstocking and understocking. Once blood or any blood component are expired, the only course of action is to discard and destroy the expired stock entirely. Similarly, blood understocking is a crucial concern which can put a human life at risk. Thus, Kumari and Wijayanayake (2016) state that blood being an invaluable product, either its wastage or shortage is undesirable.

Besides that, Hanapi et.al (2019) argue an additional aspect of blood as a perishable item which is its susceptibility to potential mismatches between blood donors, who serve as suppliers, and blood recipients, who demand blood. Unlike other inventory items where the focus is primarily on managing supply and demand quantities, blood inventory management must also consider the compatibility and matching of blood types between donors and recipients.

1.1 Blood Transfusion

Blood is classified into four groups based on the presence or absence of specific antigens on the surface of red blood cells (RBCs). ABO system which is the most prominent blood classification, includes the main blood types: A, B, AB, and O wherein, each type is again classified as either positive or negative based on the Rh antigen on RBCs. The Table 1 below summarizes the different blood groups available. During blood transfusion, accurate identification and matching of blood groups is essential. If incompatible blood is transfused, it can result in adverse reactions, as the immunity system may recognize foreign antigens as threats and trigger an immune response. The Table 2 below displays the match between donors' and recipients' blood groups.

Table 1: Available Blood Groups

Source: NBTS[1]

Blood Group	Individuals with Rh antigen on red blood cells	Individuals with no Rh antigens on red blood cells
A	A positive	A negative
B	B positive	B negative
AB	AB positive	AB negative
O	O positive	O negative

Table 2: Compatibility of Blood Groups for Transfusion

Source: NBTS[1]

		Donor's Blood Group			
		A	B	AB	O
Recipient's Blood Group	A				
	B				
	AB				
	O				

The criticality of the blood supply stems from the fact that the slightest delay can have the dire consequence of potentially costing a life. The importance of blood cannot be overstated, as every second counts and the slightest delay in receiving the required blood can lead to significant casualties. In Sri Lanka, the NBTS relies solely on voluntary blood donations (according to the statistics shown in Table 3) from regular, non-remunerated donors who do not receive any form of payment. This reliance on voluntary donations makes the blood supply and demand inherently stochastic, as donations are influenced by individual willingness and availability, causing fluctuations in supply. As demonstrated by Dehghani, Abbasi, and Oliveira (2021), blood is obtained from a semi-unpredictable source since it relies solely on voluntary donations and, currently, there is no artificial means of producing it. Despite significant advancements in medical technology, artificially producing blood with the same range of blood types and antigen profiles is currently beyond our technological capabilities and as a result, the primary source of blood and blood components are the human donors.

Additionally, to ensure the safety and suitability of blood donations, the NBTS follows specific donor selection criteria. However, as Dutta (2019) argues, that encouraging

[1] http://www.nbts.health.gov.lk/index.php

altruism and motivating individuals to donate blood itself can be challenging, and even when individuals are motivated, they may not always meet the eligibility criteria for donation.

Blood demand is influenced by factors such as population demographics, healthcare infrastructure, and disease prevalence. Unexpected events, emergencies, accidents, natural disasters, or disease outbreaks further contribute to the stochastic nature of blood demand. Moreover, NBTS of Sri Lanka encompass numerous hospitals both in government and private sector, each with its own unique patient population and specialized services, thus the demand for blood arising at multiple hospitals. Thus, as Dehghani, Abbasi, and Oliveira (2021) argue, the demand being distributed across multiple hospitals, further complicates the blood supply management.

These inefficiencies in blood inventory management can have severe consequences in the quality of patient care. Hence, addressing these challenges is crucial for the entire healthcare landscape, emphasizing the need for a robust and intelligent solution.

1.2 Problem Background

The general problem addressed in this research is the inefficiencies of the process of blood inventory management within the NBTS of Sri Lanka, and the uncertainty in blood demand which directly has an impact on the Blood Demand and Supply chain. Table 3 and Figure 3 below display the annual blood collection for the period from 2015 to 2021.

Table 3: Comparison of Annual Blood Collection

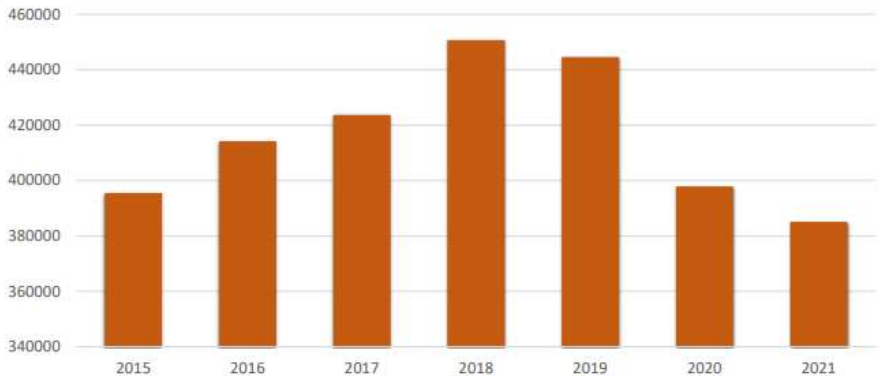
Source: Annual Statistic Report 2021 published by NBTS

Year	Voluntary Collection	Replacement Collection	Total Collection
2015	395,500	0	395,500
2016	414,175	0	414,175
2017	423,668	0	423,668
2018	450,640	0	450,640
2019	444,515	0	444,515
2020	397,833	0	397,833
2021	385,054	0	385,054

According to the annual statistic report issued by the NBTS for the year 2021, there is a noticeable decrease in blood donations after 2018. However, in interpreting the decreasing trend in blood collection, the impact of Covid-19 pandemic cannot be ignored. In Sri Lanka, the pandemic started in 2020 and therefore, factors like lockdowns, fear of infection, travel restrictions and changes in healthcare priorities further may have contributed to this decline in blood donations after 2019.

Figure 3: Yearly Comparison of Blood Collection

Source: Annual Statistic Report 2021 published by NBTS



Even with a decreasing trend in blood collection, demand fluctuations are still common and can be influenced by various factors such as seasonal variations, accidents, natural disasters, unexpected health emergencies and other external factors. Despite of the decline in blood donations by a substantial number of units due to the prevalence of Covid-19, a higher demand may still persist due to ongoing medical requirements.

Also, based on the Table 3, blood collection solely depends on voluntary donations without any replacement collection which poses challenges to the blood supply chain. Voluntary collection may lead to inconsistent and unpredictable donation patterns. As there may be periods of high donation rates followed by periods of scarcity, creating imbalances in the blood supply.

Furthermore, Kumari and Wijayanayake (2016) argue that the demand for blood is expected to experience an exponential growth in the future due to various factors such as the increase of diseases and the number of patients who required surgery and transplants, which directly drive up the blood demand. Despite the growing demand, they state that there are challenges in meeting this demand such as the increase in blood

transmitted diseases such as HIV and Hepatitis B which can lead to stricter donor screening, reducing the pool of potential donors. Additionally, the aging population suggest a smaller proportion of individuals who are eligible to donate blood further decreasing supply. Therefore, it is imperative to employ effective methodologies that enable the efficient alignment of rising demand with a diminishing supply in the future. The relevancy of addressing the necessity of an efficient inventory management is evident from these latest statistics and information, particularly with the notable decrease in blood collection which pose a serious challenge for the NBTS. Thus, developing the proposed system becomes paramount in achieving the balance between blood supply and demand while enabling proactive decision making.

1.3 Demand Prediction

Currently, the blood banks depend upon their own projections in assessing the inventory levels, which leads to either occasional wastages or shortages (Kumari & Wijayanayake, 2016). The fundamental problem lies in the fact that blood cannot be produced instantly to fulfill the demand in case of understocking. Understocking occurs due to the insufficiency of blood inventory to meet the required demand. This can result in severe repercussions, especially in critical situations where immediate access to blood is imperative. Maintaining surplus stocks may seem like a viable solution to address understocking and seasonal shortages in blood inventory. However, it may be impractical due to the perishable nature of blood. Therefore, in blood supply chain management, excess supply can lead to wastage, often referred to as overstocking, as the limited shelf life restricts both storage and utilization (Dutta, 2019).

Considering the unique complexities in blood inventory management, typical approaches such as Just-in-Time (JIT) principles aren't feasible, mainly due to the perishable nature of blood and the intricate logistical procedures involved, such as collection, testing, processing and distribution which requires adequate lead time. Thus, the necessity to investigate on a tailored inventory management approach which can specifically address the unique challenges presented in the context of blood inventory is identified. Proper demand planning is the key in achieving effective inventory management. Demand Planning can be conceptualized as the process of forecasting future demand and converting those predictions into actionable steps in meeting the

anticipated demand (Hamadneh et al., 2021). The foundation for supply chain planning is accurate demand prediction (Fortsch & Khapalova, 2016) and therefore, predictive approach emerges as the key strategy for blood inventory management. The proposed system equips the NBTS with analytics on monthly blood demand prediction for each blood type, which will result in optimization of the inventory levels, by reducing the risk of shortages and ensuring timely responses to critical demands.

1.4 Research Question

What are the most applicable methods that can be employed to optimize the inventory process of the NBTS, specifically addressing the complexities in Blood Demand and Supply Chain of Sri Lanka?

1.5 Research Objectives

- To analyze the existing manual processes of the NBTS and propose digitalization to increase robustness and efficiency.
- To identify opportunities to increase the timeliness, reliability and security of storing and processing data.
- To analyze related historical data from the hospital system connected to the NBTS, for the development of a blood demand prediction model.
- To design and implement a smart platform for blood inventory management that utilizes blood demand prediction to minimize the possibility of understocking or overstocking of blood, thereby enhancing efficiency in Blood Demand & Supply Chain.

2. Literature Review

2.1 Existing Blood Bank Management Systems

2.1.1 Blood Bank Information System in Indonesia

The Blood Bank Information System (BBIS) is developed as an application that integrates hospitals, UTD PMI (Central Blood Transfusion Unit - Indonesian Red Cross), and individual donors across Indonesia. It enables hospitals to monitor the blood supply of UTD PMI and other hospitals, facilitates blood supply requests and direct

communication among hospitals, UTD PMI, and individual donors (Ramadhan et al., 2019).

2.1.2 Blood Bank Management System in Malaysia

The Blood Bank Management System is developed to manage blood bank of Hospital Sultanah Nur Zahirah Hospital (HSNZ), which handles the stocks of the blood bank systematically by providing efficient management of blood bags received from the blood donation events (Sulaiman, Hamid & Yusri, 2015)

2.1.3 Online Blood Bank Management System in Pakistan

A web based Blood Bank Management System is developed to digitalize the blood bank operations and to facilitate the co-ordination between blood supply and demand. This system manages blood stocks and maintains information of donors, blood requests and blood availability (Hamza et al., 2019).

2.1.4 E-Blood Bank Application for Blood Transfusion Unit

E-Blood Bank Application provides real-time blood stock availability information and efficiently connects the Blood Transfusion Unit (BTU), recipients and donors. It handles blood requests and provides real-time stock information (Sumaryanti, Suwarjono & Lamalewa, 2018). The research gap exists due to the lack of a comprehensive solution that combines inventory model with demand forecasting capabilities. Thus, this study seeks to address this gap by offering a proactive, data-driven solution that employs machine learning algorithms to analyze historical blood demand patterns and identify key factors affecting demand fluctuations.

2.2 Existing Prediction Models

2.2.1 Demand Prediction Model for RBCs using Artificial Intelligence Methods

In this model, Gökler and Boran (2022) compare different AI methods such as Decision Tree (DT), Support Vector Machine (SVM), Artificial Neural Network (ANN) and Deep Learning (DL), with the intention to determine the most optimal technique for the prediction of RBCs demand. This model constitutes external environmental variables such as the number of operations, the population of provinces, and temperature etc… which affect the blood demand.

2.2.2 Demand Forecasting using Time Series Techniques

Fortsch and Khapalova (2016) in their research test several forecasting models to predict the blood demand landscape using Moving Average (MA), Exponential Smoothing (ES), and Time Series Decomposition (TSD), Autoregressive Moving Average (known as ARMA or the Box–Jenkins methodology) and Vector Autoregressive Moving Average (VARMA) models.

Another similar prediction model is proposed by Kumari and Wijayanayake (2016) to forecast the demand of platelets using three main time series techniques; Moving Average (MA), Weighted Moving Average (WMA) and Exponential Smoothing (ES) methods. The objective of both the studies is to find the best mathematical model to minimize the shortages of platelets through proper supply management.

2.2.3 Blood Demand Forecasting using Artificial Neural Networks

Khaldi et al. (2017) forecast the demand for monthly landscape of three blood components (RBCs, CP and PFC) using ANNs. The model is conducted based on 10 selected factors that may have a direct impact on the demand such as accidents, emergency cases, surgeries, risk delivery cases etc. as inputs for the neural network

Another similar model is proposed by Moslemi and Attari (2021) to forecast demand trends of Fresh frozen plasma (FFP), platelets (PLT) and RBCs based on blood groups for a time period of 30 months using ANN.

2.2.4 Forecasting Blood Demand using Auto Regressive Integrated Moving Average and Artificial Neural Network

This model is aimed to predict the demand of the 8 blood groups for the Shiraz branch of Iranian Blood Transfusion Organization using ARIMA and ANN approaches. The study is conducted to predict the demand for a 12-month horizon. The two approaches used are evaluated in order to find the most optimal technique (Sarvestani et al., 2022).

2.2.5 Prediction Model for Blood Donation using Machine Learning

This model aims to predict the blood donation and willingness to donate blood among the previous donors based on four factors such as the number of months since the last donation, the number of donations, the total volume donated and the number of months

since the last donation. This study is conducted using three regression techniques which are Simple Linear Regression, Multiple Linear Regression and Multiple Logistic Regression (Chordiya et al., 2021)

However, there is limited literature on whole blood demand prediction thus, most of the studies reviewed are on demand forecast of different blood components. Hence, addressing the unique factors in this research, the most appropriate forecasting technique is investigated.

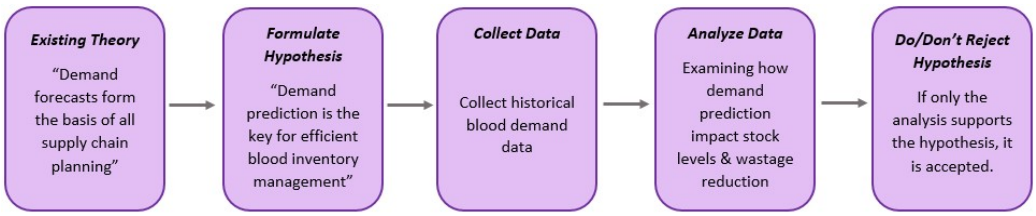
3. Methodology

3.1 Research Approach

The research approach selected for this project is Deductive reasoning. According to Hyde (2000), Deductive reasoning involves the process of testing a theory by starting with an existing theory and then examining whether this theory is applicable to specific cases.

Figure 4: Stages of Deductive Reasoning

Source: Author compiled



The Deductive reasoning process for this project is performed with the existing theory that "Demand forecasts form the basis of all supply chain planning" as presented by Chopra and Meindl (2007). Based on that, the hypothesis "Demand prediction is the key for efficient blood inventory management" is formulated such that it extends the existing theory to the context of Blood Supply chain. The Figure 05 below, depicts the stages of deductive reasoning.

Data related to blood inventory management, including historical demand data and inventory levels are gathered and analyzed to determine the impact level of demand prediction on factors such as available stock management and excess stock wastage reduction.

Based on the collected data, the hypothesis is either accepted or rejected. If the analysis supports the idea that demand prediction is indeed the key for efficient blood inventory management, the hypothesis is accepted or otherwise rejected.

3.2 Research Methodology

This project accommodates the Design Science Research Methodology, a method aimed at developing novel solutions for real-world issues. This approach involves a systematic process of crafting practical solutions, evaluating their effectiveness, and disseminating the findings (Dresch, Lacerda & Antunes, 2015). The Table 4 below explains how each stage of DSRM is addressed in this research.

Table 4: Research Methodology Execution Workflow

Source: Author compiled

Phase	Addressal in the Research Project
Problem Identification and Motivation	Identified the ***problem*** of inefficiency in blood inventory management of NBTS which leads to understocking and overstocking. Based on the perception derived through observation of current processes and stakeholder interviews, the need for a smart and proactive system was derived.
Define the objectives for a solution	Established clear ***objectives*** to enhance the overall blood supply chain through the analysis of existing processes of NBTS, identification of the opportunity to incorporate predictive capabilities and implementation of a smart solution.
Design and Development	Prepared the ***Design Specification*** identifying the architecture, UI designs and other technical specifications, thus developing the Smart Blood Inventory Management Platform iteratively.
Demonstration	Presenting a working ***prototype***, demonstrating its intended functionalities, showcasing how the solution (developed system) addresses the identified problem.
Evaluation	***Evaluation*** through extensive testing will be conducted. Performance metrics, such as demand prediction accuracy will be measured.
Communication	Finally, the ***research thesis*** will be documented including the entire research project undertaken, the process underwent. and the conclusion, in order to communicate to the field.

3.3 Fact Collection Process

During the process of fact collection, qualitative methods particularly interviews have been utilized as the primary mechanism for capturing the domain specific knowledge. Interviewing stakeholders from various departments within the NBTS, enabled to gain

a holistic understanding into the different aspects of the Blood Demand and Supply Chain which have been utilized in developing this system.

3.4 Project Management Methodology

The SCRUM methodology is used for the development of this system, which is a widely recognized agile approach that focuses on iterative and incremental progress wherein, the project is broken down in to smaller chunks called sprints (Hayat et al., 2019).

The selection of SCRUM methodology stems from the flexibility it inherently offers for the project. By breaking down the project into manageable iterations or sprints, this methodology promotes a structured yet adaptable framework that enables continuous learning and improvement. The iterative nature facilitates the incorporation of new insights and adjustments to project objectives, and seamless integration of evolving research findings.

4. System Design and Implementation

4.1 System Architecture

The proposed system is developed as a web-based system using Javascript, PHP and Python with a centralized MySQL database to store and organize all related data including donors, donations, requests, processed blood bags, donation events and demand predictions for each blood type.

The NBTS staff including the Admins, Phlebotomists, Haematologists, cluster centers and hospital staff are connected through this web application. Figure 5 below displays the system architecture.

4.2 Prediction Model Development

4.2.1 Model Justification

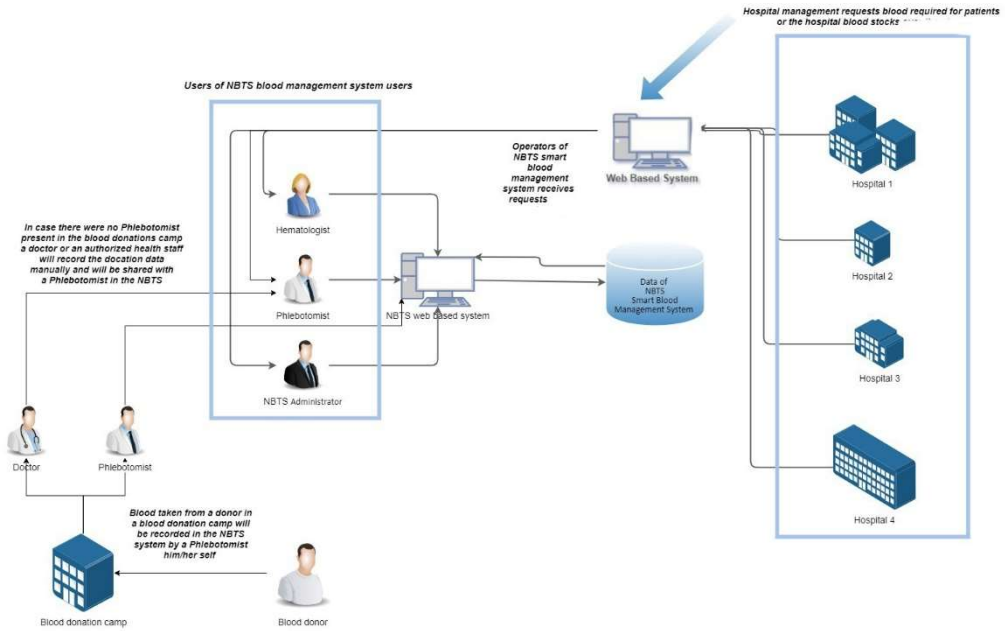
The selection of an appropriate algorithm for the blood demand prediction is a critical decision in this project, as it directly impacts the proposed system's effectiveness. The choice of the algorithm is guided by the project specific factors such as the nature of data, the size of the dataset and the problem type.

The machine learning algorithm selected for the demand prediction task is Decision Tree Regression (DTR) which is a model to forecast the value of a specific target variable based on various input factors (Gupta et al., 2017). This supervised learning approach is trained using a labelled dataset, containing input variables and variable to be predicted. Among different AI and ML techniques used to predict the demand of Red Blood Cells (which is one of the blood components), Decision Tree (DT) and Support Vector Machine (SVM) offers most preferable results (Gökler & Boran, 2022). Despite SVM outperforming in terms of performance, for this particular model, DTR is used.

The DTR offers significant advantages, particularly in handling real-world data, which is often incomplete and noisy (Feng et al., 2021). Thus, considering the smaller size of the dataset and the likelihood of containing noisy data, it is selected, also aiming to avoid overfitting that complex models like SVM are prone to, in such scenarios.

Figure 5: System Architecture of the Smart Blood Inventory Platform

Source: Author compiled



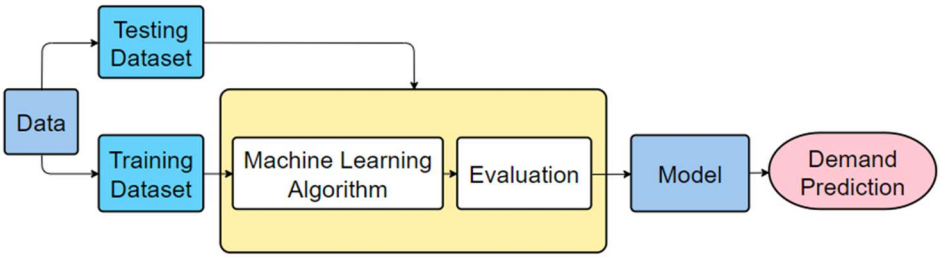
4.2.2 Model Specification

The prediction model takes into account the local demand within each cluster center. It utilizes historical data, including previous demand figures, blood requests from

hospitals, and other related factors, to generate precise and actionable forecasts. Figure 6 illustrates the workflow of the prediction model.

Figure 6: Workflow of the Prediction Model

Source: Author compiled



4.2.2.1 Data Collection

The data in this research project are collected from the NBTS related to the Karapitiya Cluster Center. The dataset ranges from the years 2020 to 2022 and consists of 36 records for each blood type.

Table 5: Repartition of the Dataset

Source: Author compiled

Dataset	Percentage (%)	No of Data Records
Training	75	26
Testing	25	10

The NBTS of Sri Lanka, transitioned to digital record-keeping in 2020 and therefore, the records before 2020 were not available. Due to the limited data utilizable for this prediction model, the training and testing datasets are partitioned as presented in Table 5 below.

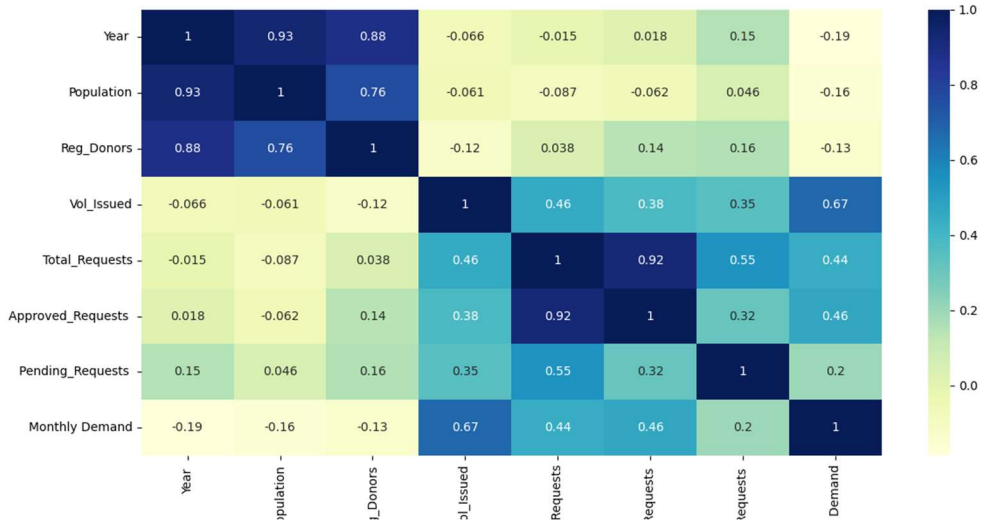
4.2.2.2 Identification of Parameters

To predict the demand of whole blood, factors that may impact the blood demand variation within a cluster center is being considered. Below factors are selected as input parameters (independent variables) in this prediction model. The dependent variable is the monthly blood demand for each blood type. It represents the volume of whole blood requires for the current month. This study considers factors that may influence blood demand variation within a cluster center such as year, month, population within the district, total number of registered donors within the district of a specific blood group,

total volume of whole blood issued in the previous month, total number of requests received by the cluster center within previous month, total number of requests approved and fulfilled during the previous month, and the total number of requests not fulfilled and remained pending during the previous month are selected as the input parameters for this prediction model.

Figure 7: Pearson Correlation among Parameters

Source: Author compiled



Pearson correlation is employed to gain insights into the degree of association between identified independent variables (input parameters), and to make data-driven decisions, identify patterns and refine the predictive model as shown in Figure 7.

4.2.2.3 Addressal of the Limitations of the Dataset

Training the model with a small dataset introduces the risk of learning noise, which can later serve as a basis for predictions. Therefore, tree pruning was utilized to simplify the decision tree model by removing sections of the tree that provided little predictive power (Ying, 2019).

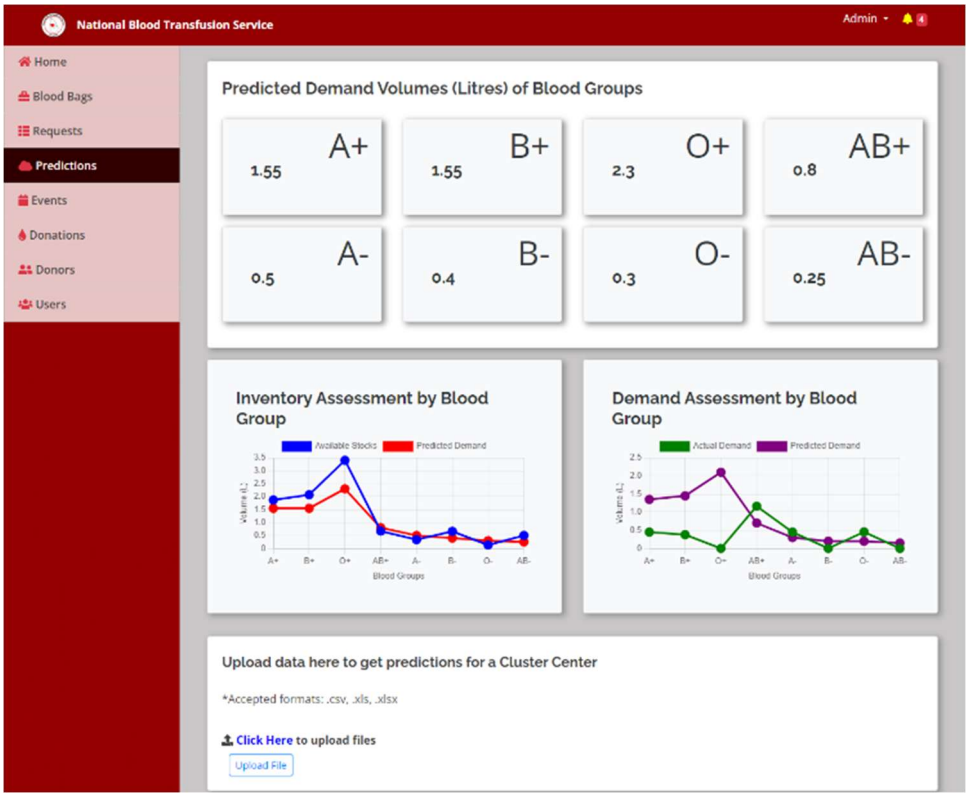
By pruning the tree, it is expected to reduce the risk of overfitting, which is particularly crucial when working with small datasets. By adjusting criteria (i.e. minimum number of samples required to split a node and the maximum depth of the tree) based on the model's performance on the testing dataset, its predictive power is enhanced even with

a limited number of training instances. Thus, the results demonstrated that the model could make reasonable predictions despite the limited dataset size.

4.3 Implementation

Figure 8: User Interface of Prediction Dashboard

Source: Author compiled



The main functionalities of the system are donor registration, entry of donations, handling and tracking of processed blood bags, handling of blood requests, handling donation events, creation of user accounts and data-driven decision making through predictive analytics. Moreover, hospitals can place their requests for blood. The most important feature of this system is the monthly blood demand prediction which employs machine learning and data analytics techniques to predict the demand for whole blood on a monthly basis. This is facilitated through the prediction dashboard displayed in Figure 8. Currently, the local demand prediction is considered for a particular cluster center with the expectation to expand to the national demand in future. Therefore, a file

upload section is included within this page, that allows users to submit datasets and receive predictions based on them for any other cluster center affiliated to the NBTS.

5. Findings and Discussion

5.1 Performance Analysis of the Prediction Model

A performance analysis is conducted to evaluate the efficiency of the prediction model and the accuracy of its forecasts. This involves the calculating three metrics: Root Mean Square Error (RMSE), Mean Absolute Percentage Error (MAPE) and the Coefficient of Determination (R^2).

$$RMSE = \sqrt{\frac{\sum_{i=1}^{n}(T_i - O_i)^2}{n}}$$

$$MAPE\ (\%) = \left(\frac{1}{n}\sum_{i=1}^{n}\frac{|T_i - O_i|}{T_i}\right) \times 100$$

$$R^2 = 1 - \frac{\sum_{i=1}^{n}(O_i - T_i)^2}{\sum_{i=1}^{n}(T_i - \bar{T}_i)^2}$$

Where O_i, T_i and $\bar{T}_i$ represents the predicted values, actual values and the Mean of the actual values respectively.

5.2 Cross Validation of the Model

To improve the reliability of the blood demand prediction model, particularly given the limited dataset of only 36 records, **k**-Fold Cross-Validation was employed with k = 6. This method partitions the dataset into six equal subsets, where the model is trained on five folds and validated on the remaining one, repeating this process six times to ensure each subset is used for validation. By averaging the results obtained for above metrics across all folds, the robustness of the model's performance evaluation is expected to enhance, reducing the risk of overfitting and improving its generalizability despite the small sample size.

5.3 Assessment of the Model

To assess the performance of this predictive model, mainly the Coefficient of Determination (R^2) is considered, baselining that the model's predictive accuracy improves when its R^2 value approaches closer to 1 (Chicco, Warrens & Jurman, 2021).

Table 6: Statistical Indicators for Performance of the Model

Source: Author compiled

Blood Type	RMSE	MAPE	R^2
O+	434.623	10.035	0.794
A+	796.111	76.869	0.641
B+	386.677	20.332	0.538
AB+	201.128	27.583	0.718
O-	89.652	11.460	0.744
A-	130.317	42.467	0.725
B-	31.544	4.346	0.942
AB-	31.741	10.332	0.935

The Table 6 summarizes the results for the aforementioned performance metrics after executing the model for the 8 blood types.

5.4 Discussion of Results

Figure 9 illustrates the results after the execution of the blood demand prediction model. This visualization presents a comparison between the actual demand and the model's predictions, individually represented for each of the blood types for a sample of 10 records in the testing data set.

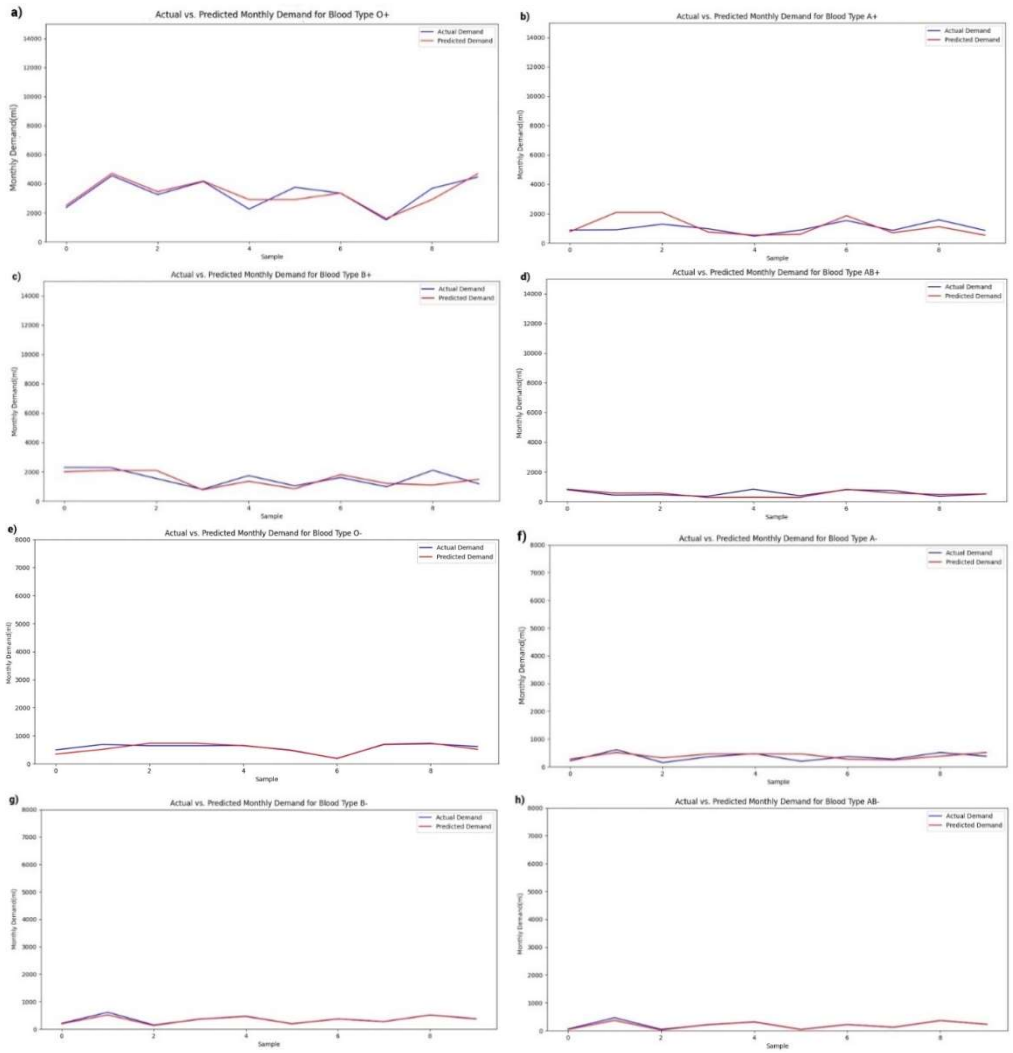
The results of this study demonstrate promising outcomes, particularly evident in the trend of the R^2 values approaching closer to 1 across all blood types. High R^2 values indicate that the predictive model accurately forecasts blood demand, with blood types B- and AB- showing the highest degree of accuracy and reliability. This high accuracy suggests that the model effectively captures the demand patterns for these rarer blood types. However, the predictions for blood types A+ and B+ reveal potential areas for improvement, as their R^2 values are comparatively lower.

The discrepancy in predictive accuracy across different blood types can be attributed to several factors. Positive blood types, which are more common and prevalent, tend to exhibit more fluctuating demand patterns. This increased variability can make it challenging for the predictive model to accurately capture and forecast the demand, leading to lower R^2 values. In contrast, negative blood types are rarer and often exhibit more stable and predictable demand patterns. This stability likely contributes to the

higher R^2 values observed for these blood types, as the model can more easily learn and predict the less variable demand.

Figure 9: Actual Demand Vs Predicted Demand: a) O positive, b) A positive, c) B positive d) AB positive, e) O negative, f) A negative, g) B negative and h) AB negative

Source: Author compiled



A key factor influencing the precision of this model is the limited number of available records. The size of the dataset directly impacts the model's ability to learn and generalize patterns in the blood demand. For positive blood types, the demand patterns tend to be more varied and complex due to their higher prevalence, which can reduce

the model's prediction accuracy as it struggles to generalize effectively with the limited data used in training. In contrast, for negative blood types, the demand is more consistent due to their rarity, which, even with the same limited dataset, allows the model to identify more stable patterns. This suggests that, while both positive and negative blood types have limited records, the model may still capture demand trends for rarer blood types with more stability.

For common blood types, larger datasets with more varied demand patterns are available, which can introduce complexity and reduce prediction accuracy. Conversely, the smaller and more stable datasets for rare blood types facilitate more accurate predictions. This highlights the importance of dataset size and quality in the development of predictive models.

6. Limitations and Recommendations for Future Researchers

One of the primary limitations of this study is the relatively small dataset. This limited historical data constrains the model's ability to fully capture and generalize the diverse variations in blood demand patterns. Thus, it is believed that a larger dataset will allow the model to better understand the fluctuations and trends in demand across various blood types, thereby enhancing its accuracy and reliability.

With the accumulation of additional historical data in future, the predictive capabilities are anticipated to improve substantially, thereby providing the model with a broader dataset, enabling it to better capture the diverse variations in demand patterns across various blood types. This will assist NBTS to formulate more targeted strategies for managing the blood inventory, emphasizing the optimization of stock levels for the available blood types.

Furthermore, future studies could explore the use of advanced machine learning techniques, which have the potential to capture more complex patterns in the data. This would improve the model's ability to handle the inherent unpredictability of blood demand, especially for common blood types that exhibit more fluctuating patterns.

7. Conclusion

This study presents a comprehensive analysis and implementation of predictive analytics for optimizing blood supply chain management, specifically tailored for the National Blood Transfusion Service of Sri Lanka. By leveraging machine learning techniques, we developed a predictive model to forecast the monthly demand for the eight blood types, addressing the critical challenges of overstocking and understocking in blood inventory management.

The findings demonstrate that the predictive model significantly improves the accuracy of blood demand forecasting, as evidenced by performance metrics such as RMSE, MAPE, and R^2. The integration of this model into the existing NBTS framework has the potential to enhance operational efficiency and ensure a more reliable blood supply across healthcare facilities in Sri Lanka.

Despite the promising results, it is important to acknowledge the limitations of this study, including the reliance on historical data and the need for continuous model validation and updating. Future research should focus on incorporating real-time data and exploring advanced machine learning techniques to further refine the predictive capabilities.

In conclusion, this research contributes valuable insights into the field of blood supply chain management, demonstrating the significant benefits of predictive analytics in optimizing inventory levels and improving healthcare outcomes. The successful implementation of this model at the NBTS of Sri Lanka underscores the transformative potential of integrating IT solutions within healthcare logistics.

REFERENCES

Chopra, S., & Meindl, P. (2007). Supply chain management: Strategy, planning & operation (pp. 187-215).

Chicco, D., Warrens, M. J., & Jurman, G. (2021). The coefficient of determination R-squared is more informative than SMAPE, MAE, MAPE, MSE, and RMSE in regression analysis evaluation. PeerJ Computer Science, 7, e623. https://doi.org/10.7717/peerj-cs.623

Chordiya, N., Fegade, P., Bhagat, D., & Desai, M. (2021). E-Blood Bank analysis using machine learning. In Proceedings of the 4th International Conference on Advances in Science & Technology (ICAST 2021).

Dresch, A., Lacerda, D. P., & Antunes, J. A. V. (2015). Design science research. Springer International Publishing.

Dehghani, M., Abbasi, B., & Oliveira, F. (2021). Proactive transshipment in the blood supply chain: A stochastic programming approach. Omega, 98, 102112. https://doi.org/10.1016/j.omega.2021.102112

Dutta, P. (2019). Blood supply chain networks in healthcare: Game theory models and numerical case studies (Doctoral dissertation). https://doi.org/10.7275/14217613

Feng, Y. N., Xu, Z. H., Liu, J. T., Sun, X. L., Wang, D. Q., & Yu, Y. (2021). Intelligent prediction of RBC demand in trauma patients using decision tree methods. Military Medical Research, 8, 1-12.

Fortsch, S. M., & Khapalova, E. A. (2016). Reducing uncertainty in demand for blood. Operations Research for Health Care, 9, 16-28.

Gökler, S. H., & Boran, S. (2022). Prediction of demand for red blood cells using artificial intelligence methods. Academic Platform Journal of Engineering and Smart Systems, 10(2), 86–93.https://doi.org/10.21541/apjess.1078920

Gupta, B., Rawat, A., Jain, A., Arora, A., & Dhami, N. (2017). Analysis of various decision tree algorithms for classification in data mining. International Journal of Computer Applications, 163(8), 15-19.

Hamadneh, S., Pedersen, O., Alshurideh, M., Al Kurdi, B., & Alzoubi, H. M. (2021). An investigation of the role of supply chain visibility in the Scottish blood supply chain. Journal of Legal, Ethical & Regulatory Issues, 24, 1.

Hamza, M., Ghaffar, J., Ibrahim, G., & Ullah, M. I. (2019). On line blood bank management system: A web application. System, 9(6).

Hanapi, W. H. W. M., Sarkan, H., Sjarif, N. N. A., Yahya, Y., & Chuprat, S. (2019). A prediction model for blood donation using multiple logistic regression. Open International Journal of Informatics, 7(Special Issue 2), 147-157.

Hayat, F., Rehman, A. U., Arif, K. S., Wahab, K., & Abbas, M. (2019). The influence of agile methodology (Scrum) on software project management. 20th IEEE/ACIS International Conference on Software Engineering, Artificial Intelligence, Networking and Parallel/Distributed Computing (SNPD), 145-149.

Hyde, K. F. (2000). Recognising deductive processes in qualitative research. Qualitative Market Research: An International Journal, 3(2), 82-90.

Khaldi, R., El Afia, A., Chiheb, R., & Faizi, R. (2017, March). Artificial neural network based approach for blood demand forecasting: Fez transfusion blood center case study. In Proceedings of the 2nd International Conference on Big Data, Cloud and Applications (pp. 1-6).

Kumari, D. M., & Wijayanayake, A. N. (2016). An efficient inventory model to reduce the wastage of blood in the National Blood Transfusion Service. In 2016 Manufacturing & Industrial Engineering Symposium, MIES (pp. 1–4).

Moslemi, A. A., & Yousefi Nejad Attari, M. (2021). Prediction of demand for blood bank products according to blood groups by a data mining approach using neural networks. International Journal of Hospital Research, 10(4).

Ramadhan, M. N. S., Amyus, A., Fajar, A. J., Sfenrianto, S., Kanz, A. F., & Mufaqih, M. S. (2019). Blood bank information system based on cloud computing in Indonesia. Journal of Physics: Conference Series, 1179(1), 012028. https://doi.org/10.1088/1742-6596/1179/1/012028

Sarvestani, S. E., Hatam, N., Seif, M., Kasraian, L., Lari, F. S., & Bayati, M. (2022). Forecasting blood demand for different blood groups in Shiraz using autoregressive integrated moving average (ARIMA), artificial neural network (ANN), and hybrid approaches. Scientific Reports, 12(1).

Sumaryanti, L., Suwarjono, S., & Lamalewa, L. (2018). E-Blood bank application for organizing and ordering the blood donation. In International Conference on Science and Technology (ICST 2018) (pp. 754-758). Atlantis Press.

Sulaiman, S., Abdul Hamid, A. A., & Najihah Yusri, N. A. (2015). Development of a blood bank management system. Procedia - Social and Behavioral Sciences, 195, 2008–2013. https://doi.org/10.1016/j.sbspro.2015.06.215

Ying, X. (2019). An overview of overfitting and its solutions. Journal of Physics: Conference Series, 1168(2), 022022. https://doi.org/10.1088/1742-6596/1168/2/022022

BRAND HATE AND THE MEDIATING ROLE OF BRAND AVOIDANCE LEADING TO NON-PURCHASING INTENTION AMONG GEN Z CONSUMERS

WEERASEKERA D, PEIRIS K

Department of Marketing and Tourism Management,

NSBM Green University, Sri Lanka

dinusha.s@nsbm.ac.lk, kalni.h@nsbm.ac.lk

Abstract

Brand hate has been a popular topic in consumer behavior research especially among Generation Z (Gen Z), who are known to possess unique psychological and behavioral patterns of consumption. However, despite the growing body of literature, brand hate remains a need for greater understanding. Hence, this concept paper investigates the impact of brand hate on non-purchasing intention which is a characteristic of Gen Z through the mediation of brand avoidance. Considering the gap identified, this concept paper suggests employing a quantitative research method and specifically Structural Equation Modeling (SEM) will be employed to examine the effects of brand hate on non-purchasing intention mediated by brand avoidance. This concept paper contributes to the existing literature on brand hate by explaining the mechanism on how brand avoidance could affect the non-purchasing intention of Gen Z. Further, identifying brand avoidance as the mediator for the expand the theoretical understanding of its pivotal role in linking brand hate and non-purchasing intention. Moreover, significant practical implications are provided for marketers, policymakers, and other decision-makers to reduce brand haters and brand avoidance.

Keywords: Brand Hate, Brand Avoidance, Non-purchasing Intention

1. Introduction

In recent years, organizations have acknowledged the importance of brand value creation among the consumers and have witnessed considerable advancement in consumer-brand relationships, highlighting the importance of brand image and positioning strategy used on consumers. Further, it is highlighted that consumer-brand relationships could either be positive or negative ranging from love to hate.

Furthermore, positive emotions are linked with brand attachments, brand loyalty, brand love while negative emotions are ranging from brand rejection, brand hate, brand sabotage and brand avoidance (Mushtaq et al., 2023).

Brand hate is currently identified as an increasingly significant phenomenon in consumer behavior, particularly among Generation Z (Gen Z) consumers (Pradhan et al., 2023). This demographic, known for its unique consumption patterns, psychological and behavioural aspects, frequently presents strong disinclination to certain brands, leading to brand avoidance and subsequently developing non-purchasing intention (Éva Kovacs Vajkai et al., 2020). Therefore, understanding the underlying mechanisms of brand hate and its impact on consumer behavior is crucial for marketers and brand managers aiming to navigate the complex landscape of different products and services. Accordingly, brand hate has been investigated in different angles by many scholars, highlighting the influence of negative emotions which drives in to negative experiences (Kucuk 2018). It is also discussed that the phenomenon of brand hate is multifaceted, involving both emotional and cognitive responses. Feelings of brand betrayal, stemming from perceived false characteristics of the brand, can intensify brand hate and lead to either avoidance or revenge behaviors (Knittel et al., 2016). However, despite the growing body of literature, brand hate remains a need for greater understanding (Mushtaq et al., 2023). Further, it is discussed that even brand hate has been identified as a recent phenomenon it has not been researched much (Jabeen et al., 2022; Powell et al., 2022).

In the context of Gen Z consumers, brand avoidance behaviors are particularly evident (Éva Kovacs Vajkai et al., 2020). Due to this generation's heightened awareness of social and ethical issues, coupled with their distinct identity needs, it has made them more sensitive to brand avoidance triggers (Éva Kovacs Vajkai et al., 2020). Furthermore, agreeing on the same, brand hate has been characterized by emotions such as disgust, contempt, and anger, which can lead to various negative consumer behaviors, including brand avoidance and non-purchase intention (Fetscherin, M. (2019). Moreover, brand avoidance is identified as a second-order construct comprising dimensions such as moral, identity, deficit-value, experiential, and advertising-related avoidance, each contributing to a consumer's decision to refrain from purchasing certain brands (Odoom, R., Kosiba, J., Djamgbah, C., & Narh, L., 2019). The relationship

between brand avoidance and non-purchasing intention is further validated indicating that consumers who experience brand avoidance are more likely to exhibit non-purchasing behavior (Odoom, R., Kosiba, J., Djamgbah, C., & Narh, L., 2019). Additionally, identity, moral, and deficit-value avoidance are particularly influential in shaping consumer purchasing decisions, as these forms of avoidance reflect deeper psychological and ideological conflicts with the brand (Sabog, A., Bludo, G., & Chovancová, M., 2023). Also, experiential avoidance, stemming from negative firsthand experiences, plays a crucial role in non-purchasing intention, as unmet expectations can deter future purchases (Lee, M., Motion, J., & Conroy, D., 2009).

Furthermore, studies have shown that brand hate can manifest in both active and passive forms, with active brand hate driving desires for revenge and passive brand hate leading to brand avoidance (Odoom et al., 2019). Hence, brand avoidance is described as the deliberate decision by consumers to steer clear of or reject a brand. This phenomenon is part of a broader anti-consumption behavior where consumers consciously choose not to engage with certain brands despite having the financial means to do so (Odoom et al., 2019).

In summary, considering the conceptualization and connections built as per previous literature in terms of brand hate, brand avoidance and non-purchasing intention, this concept paper aims to explore the conceptualization of the mediating role of brand avoidance in the relationship between brand hate and non-purchasing intention among Gen Z consumers. By examining the various dimensions of brand avoidance and their impact on consumer behavior, this research seeks to provide valuable insights for brand managers and marketers striving to mitigate the adverse effects of brand hate and enhance brand loyalty.

8.1 1.1 Research Objectives

RO1: To identify the impact of brand hate on non-purchasing intention of Gen Z.

RO2: To identify the impact of brand avoidance on non-purchasing intention of Gen Z.

RO3: To examine whether there is a mediating impact of brand avoidance on the relationship between brand hate and non-purchasing intention of Gen Z.

2. Literature Review and Hypothesis Development

8.2 2.1 Brand Hate and Non-Purchasing Intention

Recent consumer behavior researchers have identified a major focus on anti-consumption trends influencing consumer loyalty and purchasing intention (Zarantonello et al., 2018). In an organizational perspective, it is crucial that how firms deal with brand haters influences their non-purchasing intention (Kucuk, 2018). However, some studies have highlighted that non-purchasing intention has been caused by the failures of organizations (Liao & Keng, 2013) and customers are avoiding interactions with the same firm as a result of negative experiences they had to encountered. In addition, it has been revealed that word of mouth involves informal and personal communication between individuals (Sajid et al., 2024) and when negative word of mouth rises it results in criticizing, negative feedback, complaining (Lee et al., 2022) and it drives consumers showing non-purchasing intention. Similarly, when customers are not happy with the current brands, they are unlikely to repeat the purchases (Slamet & Yuliana, 2024). Accordingly, the hypothesis below has been derived,

H1: Brand Hate significantly impacts Non-Purchasing Intention

8.3 2.2 Brand Hate and Brand Avoidance

Resent psychological researchers have identified two categories of negative reactions, such as passive (brand avoidance) and active behavior (negative word of mouth) (Hegner et al., 2017). Brand avoidance is highlighted on how consumers change their mind to avoid the brand and switch to another competitor (Hegner et al., 2017) while negative word of mouth is considered as the extent to which an individual speaks or writes poorly about a brand (Hegner et al., 2017). Further, it is highlighted that people are more likely to share negative experiences than positive experiences with the brand. Similarly, according to prior research, brand relationships are determined by the emotional connectedness of consumers and how they respond to the brand (Sabrina et al., 2017). Hence, just as consumers can experience positive emotions, they may also encounter negative emotions, and this results in avoidance behavior (Sabrina et al., 2017).

In addition, according to the expectation-confirmation theory and anti-consumption literature, unfavorable brand experience could lead to brand avoidance (Sajid et al., 2024). This is due to the negative experiences with brand which may ultimately lead to avoidance behavior (Costa & Azevedo, 2022). Hence, it is evident that brand hate leads to brand avoidance based on the arguments from existing literature. Accordingly, the hypothesis below has been derived,

H2: Brand Hate significantly impacts Brand Avoidance

8.4 2.3 Brand Avoidance and Non-Purchasing Intention

Brand avoidance is where consumers deliberately reject a brand and consciously ignore the usage and purchase of the particular brand (Sabrina et al., 2017) despite their financial capabilities. Moreover, existing literature highlighted that brand avoidance is different from other brand negative relationships (Sabrina et al., 2017) where boycotts form anti-consumption, and it is among the peer groups while avoidance is individual based (Albrecht et al., 2013). Further, some scholars have argued that consumers who are avoiding brands could gain back than the ones who hate (Sabrina et al., 2017).

In addition, scholars have identified different types of avoidances such as moral avoidance, identity avoidance, deficit-value avoidance, experiential avoidance, and advertising-related avoidance. Moral avoidance has been identified where brand promises mismatch the consumers' beliefs. Identity avoidance is when consumers avoid brands which do not fit their self-identity. Further, experiential avoidance refers to undelivered brand promises from the unpleasant store environment and inconveniences. Deficit-value avoidance means that the brand value does not match the cost that consumers spend in purchasing. Finally, advertising-related avoidance refers to where consumers eliminate advertising relating to the brand (Mushtaq et al., 2023).

Previous scholars have argued that brand avoidance could lead to non-purchase intention (Sabri & Obermiller, 2012). Similarly, it is identified that brand avoidance emphasizes anti-choice which may lead consumers not to make purchases (Abid & Khattak, 2017). Accordingly, the hypothesis below has been derived,

H3: Brand Avoidance significantly impacts Non-Purchasing Intention.

In the discussion of mediating impact of brand avoidance in the relationship between brand hate and non-purchasing intention, Filho et al., (2022), have highlighted that

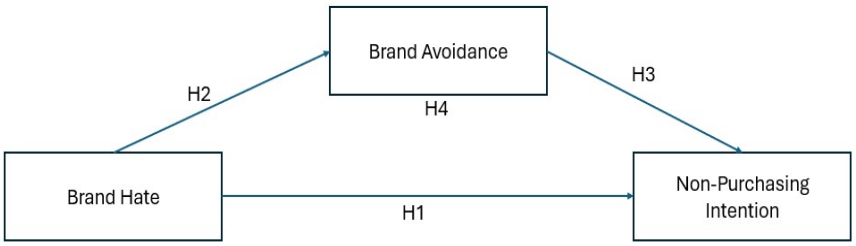
brand avoidance played as a mediator to the brand hate and its consequences, such as non-purchasing intention. In supporting the above relationship, brand hate affects brand avoidance thereby non-purchasing intention. According to the above arguments below hypothesis has been derived,

H4: Brand Avoidance will impact the relationship between Brand Hate and Non-Purchasing Intention.

8.5 Conceptual Framework

Figure 1: Conceptual Framework

Source: Authors



3. Methodology

The present concept paper focuses on identifying the factors leading to non-purchasing intention with the mediation role of brand avoidance. According to previous literature, a qualitative approach, such as document analysis, has been effectively used to explore the impact of brand avoidance on consumer purchasing decisions, identifying key factors like identity, moral, and deficit-value avoidance (Sabog et al., 2023). Also, it is recommended that future research in this area could benefit from applying a quantitative method under the deductive approach (Saunders et al., 2008). Thus, quantitative methods, including structural equation modeling, could be employed to examine the effects of brand hate on consumer behaviors such as brand avoidance and switching intention (Günaydin et al., 2021; Rahimah et al., 2022).

Structural Equation Modelling (SEM) is a common method frequently used to analyze relationships between variables in brand avoidance studies. For instance, partial least squares SEM could be applied to develop and validate scales for measuring brand avoidance, examining its multidimensional nature across different consumer groups and

markets (Khan et al., 2019). Also, regression analysis could be utilized to understand the dynamics between brand hate and brand avoidance, offering insights into consumer attitudes and behaviors (Gusnadi., 2024).

Thus, these methodologies collectively offer a comprehensive approach to understanding the complex interplay between brand avoidance, brand hate, and purchasing intention. Moreover, effective research methodologies for studying brand avoidance include a mix of quantitative techniques like SEM and surveys, qualitative methods such as interviews and focus groups, and innovative approaches like multidimensional scaling (Kovacs et al., 2020). These methodologies help uncover the multifaceted nature of brand avoidance, providing valuable insights for both academic research and practical applications in marketing (Lee et al., 2009).

4. Implications

8.6 4.1 Theoretical Implications

This concept paper contributes to the growing body of literature brand hate by explaining the mechanism on how brand avoidance affects the non-purchasing intention. Further, identifying brand avoidance as the mediator for the expand the theoretical understanding of its pivotal role in linking brand hate and non-purchasing intention.

8.7 4.2 Managerial Implications

This concept paper focuses on the strategies to deal with brand haters. According to previous studies it is crucial that companies constantly monitor consumer interactions with the brand to identify their reactions. Further, research shows that most loyal customers could be the most severe haters of the brands (Grégoire & Fisher, 2008). Hence, it is vital to identify the strategies and implement them accordingly to overcome that issue. Recent researchers have identified that positive reference groups can establish congruity among consumers (Sabrina et al., 2017). Further, moral, social, legal wrongdoing of the company can reduce the consumers' ideological incompatibility with the brand. Similarly, corporate social responsibility activities can enhance consumers' trust towards the brand and the company. Hence, it is evident that contributing to societal wellbeing results in reducing haters of brands and brand avoidance. However,

as per the previous findings, it is not possible to perform the brand with zero heaters but would be able to minimize the impact of brand haters on the company.

5. Conclusion

This concept paper aims to contribute to the existing knowledge of brand hate towards non purchasing intention. Further, it focuses on understanding how brand hate leads to brand avoidance and thereby to non-purchasing intention. According to previous literature, the direct relationships of brand hate and brand avoidance towards non-purchasing intention along with a mediating impact of brand avoidance have been developed. Moreover, based on previous literature, it has been highlighted that a major focus on anti-consumption trends influencing consumer loyalty and purchasing intention (Zarantonello et al., 2018). Similarly, negative experiences with brand which may ultimately lead to avoidance behavior (Costa & Azevedo, 2022). Hence, it is noteworthy that initiations to enhance the discussion on brand hate, brand avoidance and thereby the relationship towards non-purchasing intention.

REFERENCES

Abid, R., & Khattak, A. (2017). Brand avoidance motivators stimulate to brand equity in the mediating role of brand hate: a case of smartphone industry of Pakistan. Journal of Accounting and Marketing, 6(3), 250.

Albrecht, Carmen-Maria, et al. "Exploring why consumers engage in boycotts: Toward a unified model." Journal of Public Affairs 13.2 (2013): 180-189.

Costa, J., Azevedo, A., 2022. Beyond brand hate: are you willing to forgive a negative experience with your smartphone mobile communications' brand? Corp. Reput. Rev. https://doi.org/10.1057/s41299-022-00139-7.

Curina, I., Francioni, B., Hegner, S. M., & Cioppi, M. (2020). Brand hate and non-repurchase intention: A service context perspective in a cross-channel setting. Journal of Retailing and consumer services, 54, 102031. https://doi.org/10.1016/j.jretconser.2019.102031

Fetscherin, M. (2019). The five types of brand hate: How they affect consumer behavior. Journal of Business Research. https://doi.org/10.1016/J.JBUSRES.2019.04.017.

Gonçalves Filho, C., Moreira, E. M., Braga Chinelato, F., & Ferreira Santos, M. (2022). PASSIVE CONSEQUENTS OF BRAND HATE: THE MEDIATING ROLE OF BRAND AVOIDANCE. Multidisciplinary business review, 15(1), 77-89.

Grégoire, Y., Tripp, T. M., & Legoux, R. (2009). When customer love turns into lasting hate: The effects of relationship strength and time on customer revenge and avoidance. Journal of marketing, 73(6), 18-32.

Gusnadi, F., Efendi, M., & Apriyana, N. (2024). ANALISIS BRAND HATE TERHADAP BRAND AVOIDANCE PADA MEREK STARBUCKS KONTEKS ISSUE ISRAEL-PALESTINA. Jurnal Cahaya Mandalika ISSN 2721-4796 (online). https://doi.org/10.36312/jcm.v5i1.2726.

Günaydin, R., & Yıldız, E. (2021). Determining the Motives and Behaviors of Brand Hate. , 474-498. https://doi.org/10.4018/978-1-7998-5077-9.ch023.

Hegner, S.M., Beldad, A.D. and Kamphuis op Heghuis, S. (2014), "How company responses and trusting relationships protect brand equity in times of crises", Journal of Brand Management, Vol. 21 No. 5, pp. 429-445

Hegner, S. M., Fetscherin, M., & Van Delzen, M. (2017). Determinants and outcomes of brand hate. Journal of Product & Brand Management, 26(1), 13-25. Doi 10.1108/JPBM-01-2016-1070.

Jabeen, F., Kaur, P., Talwar, S., Malodia, S., & Dhir, A. (2022). I love you, but you let me down! How hate and retaliation damage customer-brand relationship. Technological Forecasting and Social Change, 174, 121183. https://doi.org/10.1016/j.techfore.2021.121183.

Khan, M., Ashraf, R., & Malik, A. (2019). Do identity-based perceptions lead to brand avoidance? A cross-national investigation. Asia Pacific Journal of Marketing and Logistics. https://doi.org/10.1108/APJML-12-2017-0332.

Kovacs, É., & Zsóka, Á. (2020). Brand avoidance behaviour of Gen Z towards fast fashion brands. Vezetéstudomány / Budapest Management Review. https://doi.org/10.14267/veztud.2020.05.04.

Kucuk, S.U. (2008), "Negative double jeopardy: the role of anti-brand sites on the internet", Journal of Brand Management, Vol. 15, pp. 209-222. DOI: 10.1057/palgrave.bm.2550100

Kucuk SU (2018) Brand hate: navigating consumer negativity in the digital world. Springer International Publishing, Berlin

Lee, M., Motion, J., & Conroy, D. (2009). Anti-consumption and brand avoidance. Journal of Business Research, 62, 169-180. https://doi.org/10.1016/J.JBUSRES.2008.01.024.

Lee, S.B., Liu, S.H., Maertz, C., 2022. The relative impact of employees' discrete emotions on employees' negative word-of-mouth (NWOM) and counterproductive workplace behavior (CWB). J. Prod. Brand Manag. 31 (7), 1018–1032. https://doi.org/ 10.1108/JPBM-07-2021-3555.

Liao, T. H., & Keng, C. J. (2013). Online shopping delivery delay: Finding a psychological

recovery strategy by online consumer experiences. Computers in Human Behavior, 29(4), 1849-1861.

Mushtaq, F. M., Ghazali, E. M., & Hamzah, Z. L. (2024). Brand hate: a systematic literature review and future perspectives. Management Review Quarterly, 1-34. https://doi.org/10.1007/s11301-023-00402-z

Odoom, R., Kosiba, J., Djamgbah, C., & Narh, L. (2019). Brand avoidance: underlying protocols and a practical scale. Journal of Product & Brand Management. https://doi.org/10.1108/JPBM-03-2018-1777.

Powell, A., Stavros, C., & Dobele, A. (2022). Transmission of negative brand relevant content on social media. Journal of Product & Brand Management, 31(4), 671-687. DOI 10.1108/JPBM-12-2020-3258

Rahimah, A., Dang, H., Nguyen, T., Cheng, J., & Kusumawati, A. (2022). The subsequent effects of negative emotions: from brand hate to anti-brand consumption behavior under moderating mechanisms. Journal of Product & Brand Management. https://doi.org/10.1108/jpbm-12-2021-3778.

Sabog, A., Bludo, G., & Chovancová, M. (2023). The influence of brand avoidance on consumers purchasing decision. European Conference on Research Methodology for Business and Management Studies. https://doi.org/10.34190/ecrm.22.1.1804.

Sajid, M., Zakkariya, K. A., Suki, N. M., & Islam, J. U. (2024). When going green goes wrong: The effects of greenwashing on brand avoidance and negative word-of-mouth. Journal of Retailing and Consumer Services, 78. https://doi.org/10.1016/j.jretconser.2024.103773

Slamet, F. A., & Yuliana, L. (2024). The Impact of Brand Hate and Negative E-WOM on Non Purchase Intention (Case Study on American Food). Journal of Applied Business Administration, 8(2), 311-323.

Zarantonello, L., Romani, S., Grappi, S. and Bagozzi, R. (2016), "Brand hate", Journal of Product & Brand Management, Vol. 25 No. 1, pp. 11-25. https://doi.org/10.1108/JPBM-01-2015-0799

ARTICLES IN THIS ISSUE