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Foreword

It is our privilege to present the Proceedings of the 1st Symposium of Logistics, Business and Technology 2025 (SLBT 2025). Organised by the Peninsula Research Management Centre (PRMC) and hosted at Peninsula College Georgetown, The Ship Campus. This volume celebrates research led by our undergraduate and postgraduate students, whose work demonstrates that curiosity, when disciplined by method and guided by mentorship, can produce insight with real-world consequence.

The symposium provided a platform to share emerging findings, methodologies, and applied insights across logistics, business, and technology. The proceedings were screened and peer-reviewed for relevance, originality, and clarity. Each contribution sets out a clear problem focus, outlines the approach or design, and highlights implications for practice, policy, or further inquiry.

Beyond dissemination, SLBT 2025 aimed to cultivate a student-led research culture—linking classroom learning with real-world challenges, encouraging collaboration across disciplines, and strengthening research communication skills. We hope this publication serves as a useful reference for educators, industry partners, and fellow students, and that it will stimulate future projects and partnerships.

Our sincere thanks to the authors for their diligence, the reviewers for constructive and timely evaluation, academic supervisors and mentors for steady guidance, the Programme Committee for a coherent scholarly agenda, and the student volunteers and PRMC team whose unseen labour made both the symposium and this volume possible.

We invite you to read generously, to question boldly, and to connect with the authors. May the work begun here travel beyond these pages—into partnerships, policies, and practices that are innovative, ethical, and sustainable.

Ts Tung Chee Kuan
President of Peninsula Higher Education Group
Chief Executive of Peninsula College Georgetown

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Factor Influencing Turnover Intention Among Truck Drivers in Penang

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ABSTRACT

The purpose of this study is to look at the factors influencing Penang truck drivers' intentions to quit their jobs. Grounded in Social Exchange Theory, the research investigates the relationship between turnover intention and job satisfaction, work-family conflict, and job insecurity. This study uses a quantitative approach, gathering data from a sample of 100 truck drivers via a structured online survey. The collected data were analysed using descriptive statistics, factor analysis, reliability testing, correlation, and regression analysis. The results showed that job satisfaction has a negative link with turnover intention, but work-family conflict and job insecurity significantly increase turnover intention. Moreover, the findings emphasise the importance of understanding the factors influencing turnover intention among truck drivers in Penang. Furthermore, this study provides important insights into the relationships among job insecurity, work-family conflict, job satisfaction, and turnover intention.

Keywords: Social Exchange Theory (SET); Turnover Intention (TI); Job Satisfaction (JS); Work-Family Conflict (WFC) and Job Insecurity (JI)

1. INTRODUCTION

E-commerce's double-digit growth in developed markets was accelerated by COVID-19, spurring a surge in last-mile deliveries (Viu-Roig and Alvarez-Palau, 2020). At the same time, a global shortage of truck drivers has strained the trucking industry (Mittal et al., 2018). This led to customer disloyalty, delivery delays and diminished profitability (Rahmat et al., 2021). In Malaysia, this shortage is worsened by an aging driver population and migration to higher-paying opportunities in Singapore (Kamal, 2025).

In today's global e-commerce landscape, freight transport is crucial. However, Malaysia's trucking industry faces a severe driver shortage, worsened by high turnover and declining interest from the younger generation (Zahiid, 2024). Truck drivers often earn only 15 to 20% of delivery charges, with much of it spent on expenses and assistant allowances (Zahiid, 2024). For example, high expenses for maintenance, fuel, and frequent fines make it challenging for drivers to maintain a steady monthly income (Loheswar, 2024). Moreover, long routes and limited trips further strain drivers, with some being blacklisted due to unpaid fines (Loheswar, 2024, Zahiid, 2024). This nationwide issue underscores the need to explore why truck drivers in Penang intend to leave their jobs.

SET explains social behaviour as a process of mutual give-and-take (Afzal et al., 2019). Homans (1958) proposes SET as where individuals seek to maximize rewards and minimize costs. It has been widely used to understand organizational relationships, particularly between employers and employees (Harden, Boakye and Ryan, 2018). According to Blau's (1964), when employees feel fairly compensated and valued, they are more likely to stay satisfied and retain their roles. Conversely, if the perceived rewards do not match their contributions, they may choose to leave. In the context of truck drivers, a strong, positive exchange relationship with their employer can increase retention (Thomas, Liao-Troth and Williams, 2020).

Dependent variable of this finding is TI, and the independent variables are JS, WFC and JI. There are 3 hypothesis development have been proposed in this finding, which is (H_1) JS influences TI, (H_2) WFC influences TI and (H_3) JI influences TI. Firstly, H_1 is proposed as truck drivers often face dissatisfaction from long hours, tough schedules, and low pay, while better compensation and work-life balance attract more applicants and reduce turnover (Wygal et al., 2021). Next, H_2 is proposed as truck drivers often face irregular hours and time away from home, leading to WFC and dissatisfaction with balancing job and family responsibilities (Shin and Jeong, 2020). Moreover, H_3 is proposed as JI among truck drivers may arise from strict regulations, like driving hour limits and weight restrictions, which can result in blacklisting for violations (García et al., 2018).

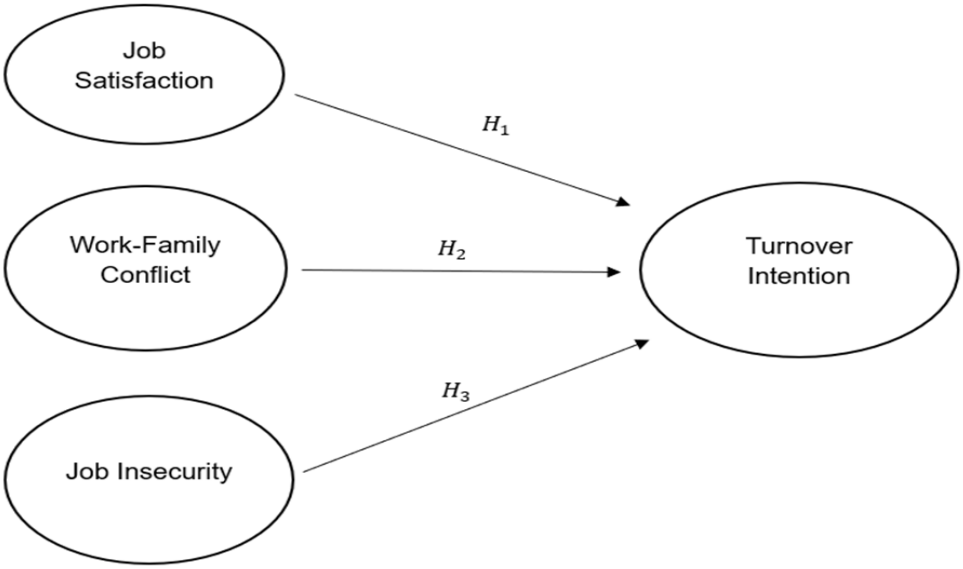

Figure 1 Conceptual framework created by researcher

2. METHODOLOGY

The researcher used a quantitative, cross-sectional study to identify factors influencing truck driver turnover in Penang's logistics industry, following a deductive approach to test theories through a one-time questionnaire-based investigation (Saunders, Lewis, and Thornhill, 2019). Next, this study uses convenience sampling to collect data from truck drivers in Penang due to practical factors like accessibility and time constraints. Although this method is efficient, it may introduce selection and non-response biases, thereby limiting sample diversity and reducing the study's external validity (Saunders, Lewis, and Thornhill, 2019). Moreover, the researcher will collect data using a structured Google Forms questionnaire focused on JS, WFC, JI, and TI among truck drivers in Penang. The survey uses a five-point Likert scale and will be shared via QR code through logistics contacts and hubs. To boost responses, personal outreach and sharing will be encouraged. Consent, confidentiality, and anonymity are ensured, with data collected from February to March 2025.

Furthermore, the researcher translated and adapted the questionnaire into simple English and Bahasa Malaysia to improve clarity for truck drivers. It includes five sections, JS, WFC, JI, TI and demographics, each of it will be measured on a five-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree). Additionally, this study has employed Statistical Product and Service Solutions (SPSS) to process the data collected from the questionnaires. Which includes analysis like descriptive analysis, factor analysis, reliability test, correlation analysis and regression analysis.

3. ANALYSIS AND RESULTS

Table 1 Hypothesis Testing

H	Relationship	Beta (β)	Std Error	*T* value	R^2	Decision
H_1	JS → TI	-0.291	0.071	-4.329	0.736	Not Supported
H_2	WFC → TI	0.198	0.084	2.799**	0.736	*Supported*
H_3	JI → TI	0.505	0.076	7.008**	0.736	*Supported*

$p < 0.05$*, $p < 0.01$**

Table 1 show R^2 value of 0.736, JS→TI is negative and not significant (β = -0.291, T = -4.329, p < 0.01). WFC→TI is positive and significant (β = 0.198, T = 2.799, p < 0.01). JI →TI is positive and significant (β = 0.505, T = 7.008, p < 0.01).

4. DISCUSSION

The proposed hypothesis (H_1) stated that JS influences TI, but the data analysis showed no significant support for this relationship. This aligns with Pinnington, Mir, and Ai (2023), who found a negative relationship between JS and the TI. Next, the proposed hypothesis (H_2) stated that WFC influences TI, and the data analysis showed this relationship was supported. This aligns with Belwal and Belwal (2023), who discovered a significant association between the WFC and TI. Lastly, the proposed hypothesis (H_3), stated that JI influences TI, and the data analysis showed that relationship was supported. This aligns with Probst et al. (2021), who found a strong and positive connection between JI and the TI.

This study found no direct link between JS and TI among truck drivers. Future research should explore mediating or moderating factors like job stress or work engagement to better understand this relationship.

This study has several limitations. The small sample size of 100 truck drivers from Penang and the use of convenience sampling may limit the generalizability of the findings. Self-reported questionnaires could introduce response bias, and the geographic focus on Penang may not reflect broader experiences. Despite these limitations, the study provides valuable insights into factors affecting truck driver turnover intention.

Future research on truck drivers' turnover intention in Penang should use larger, more diverse samples to improve generalizability. A mixed-method approach, combining surveys with interviews or focus groups, could provide deeper insights and reduce bias. Expanding the study to other regions or countries would allow for cross-cultural comparisons. Additionally, exploring factors such as organizational culture and leadership may provide a more comprehensive understanding of turnover intention among truck drivers in Penang.

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Factors Affecting Risky Riding Behaviours Among Food Delivery Riders in Penang, Malaysia

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ABSTRACT

This research was aimed at examining the relationship between factors affecting risky riding behaviour among food delivery riders in Penang, Malaysia. Concerns have been raised as accidents involving food delivery riders not only disrupt traffic but also endanger their lives. There is limited research on factors influencing food delivery riders' risky riding behaviour in Malaysia. A total of 105 food delivery riders has participated in this research. To contribute to existing literature, the JD-R theory was employed to investigate the causes of risky riding behaviour. Time pressure (TP) and working environment (WE) were found to be positively associated with job burnout (JBO). When riders are experiencing job burnout, the likelihood of engaging in risky riding is higher. Interestingly, the study revealed that job motivation (JMO) had no associations with risky riding behaviours (RRB). From this study, food delivery companies and the government can impose temporary pauses on the app or impose stricter regulations to reduce burnout among riders. This would lower risky riding behaviours and accident rates among food delivery riders.

Keywords: Food delivery riders; Job burnout; Job motivation; Risky riding behaviour

1. INTRODUCTION

Technology today has revolutionised, particularly in the e-commerce industry, providing ease for both customers and businesses. E-commerce refers to an online platform whereby users can select and purchase products via the Internet without being in a physical store (Qian, He and Shi, 2024). Food delivery services provided convenience for consumers with the availability of food delivery platforms. These platforms rely heavily on food delivery riders to facilitate the delivery of food to consumers (Yu, Zhang and Yun, 2024), thus leading to an increased job opportunity. In Malaysia, 66,000 Bumiputera individuals ventured into food delivery and are continuing to surge over time (Rusli *et al*., 2022; Bernama, 2021).

As the number of riders and frequency of delivery service increase, accidents were reported to be inevitable (Nguyen-Phuoc *et al*., 2022). Between 2018 to May 2020, Malaysia recorded a total of 1,200 accidents involving food delivery riders (Ibrahim, Carvalho and Tan, 2023). Accidents put both the lives of food delivery riders and other road users at stake. Therefore, examining the relationship between factors influencing food delivery riders' risky riding behaviour is critical.

The Job Demands-Resources (JD-R) theory, which asserted that job demands and job resources impact job burnout (JBO) and job motivation (JMO) (Bakker and Demerouti, 2007), was adopted to investigate the effects of work characteristics on food delivery riders' performance outcomes. Time pressure (TP) and working environment (WE) were grouped under job demands, while reward and feedback were grouped under job resources. High job demands are likely to cause burnout towards employees. To increase wages, food delivery riders face time pressure as riders tend to rush to complete deliveries faster (Zheng *et al*., 2019). The working environment such as exposure to adverse

weather also causes exhaustion (Nguyen-Phuoc *et al*., 2023; Nguyen-Phuoc *et al*., 2022). Hence, hypothesis 1 was proposed.

H1: Job demands have a direct and positive impact on job burnout

When employees experience burnout, safety practices are often ignored. This was evident among taxi drivers, food delivery riders, and workers in the mining industry (Husain, Mohamad and Idris, 2019; Nguyen-Phuoc *et al*., 2023; Tong *et al*., 2019). Thus, hypothesis 2 was proposed.

H2: Job burnout has a direct and positive impact on risky riding behaviour

Rewards (REW) act as an extrinsic motivation, boosting confidence levels at work (Nguyen-Phuoc *et al*., 2024). Feedback (FEE) from customers also allow riders to understand customers' demand which motivates the riders to improve future deliveries (Nguyen-Phuoc *et al*., 2022). Hence, hypothesis 3 was proposed.

H3: Job resources have a direct and positive impact on job motivation

Based on past studies, motivated employees tend to adhere to safety practices (Nguyen-Phuoc *et al*., 2024; Nguyen-Phuoc *et al*., 2023). However, Wahyudi, Silaban and Aulia (2020) found that job motivation causes unsafe behaviour. To increase wages, riders are motivated and would engage in aggressive riding. Ni *et al*. (2022) supported this view, arguing that motivated employees engage in unsafe behaviour in the construction industry to achieve better rewards. Motivated riders may also engage in risky riding to avoid negative feedback (Nguyen *et al*., 2024). Thus, hypothesis 4 was proposed. Figure 1 illustrates the conceptual framework for this study.

H4: Job motivation has a direct and positive impact on risky riding behaviour

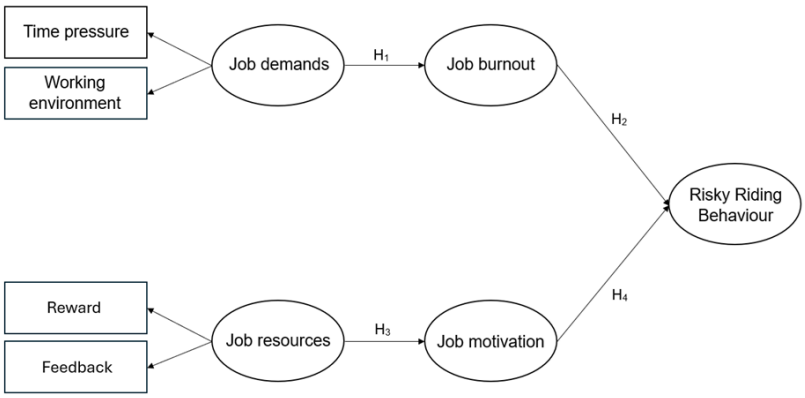

Figure 1 Conceptual Framework

2. METHODOLOGY

A quantitative approach was used to quantify the data gathered and determine relationships between study variables. A cross-sectional study was implemented, collecting data from January 2025 to February 2025. Convenience sampling technique was used due to the difficulty in randomizing riders

as researcher does not have access to all riders. Data was collected outside shopping malls and restaurants around Penang. Questionnaire was used to collect data with each item being measured using a five-point Likert scale. A five-point Likert scale was adapted instead of a seven-point Likert scale from Nguyen-Phuoc *et al*. (2023) and Nguyen-Phuoc *et al*. (2024). Dawes (2008) asserted that there was not much difference in data characteristics between the two scales. Given the nature of rider's profession, time is a precious aspect, therefore, a five-point Likert scale will induce greater participation rates. To analyse the data, SPSS was used to run descriptive analysis, factor analysis, and multiple regression analysis.

3. ANALYSIS AND RESULTS

A total of 105 samples were collected with a majority of 95.2% being male. Most of the samples (59%) were aged between 25-34 years old, had 1-2 years of working experience (39%) and held secondary school qualification (61.9%).

To ensure validity, factor loadings should exceed 0.5 (Cheung *et al*., 2023). After suppressing small coefficients, TP4 was removed as factor loading was below 0.5. Based on Figure 1, TP and WE are variables under job demands. Since TP and WE fell under different components, it was treated as two different variables for this research. Subsequently, REW, FEE, and JMO were grouped under the same component. Therefore, the three variables were summated into a single variable as JMO. Hence, restatement of hypotheses was done, and a revised conceptual framework is illustrated in Figure 2. To ensure data was suitable for testing, Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.769, exceeding the minimum threshold of 0.6 (Shrestha, 2021). Additionally, Bartlett's test of sphericity was also calculated (1482.102) to ensure data was suitable for factor analysis. The total variance of 64.12% was also explained, exceeding 50%, and with eigenvalues greater than one (Shrestha, 2021).

Restatement of Hypotheses

H_1: Time pressure has a direct and positive impact on job burnout

H_2: Working environment has a direct and positive impact on job burnout

H_3: Job burnout has a direct and positive impact on risky riding behaviour

H_4: Job motivation has a direct and positive impact on risky riding behaviour

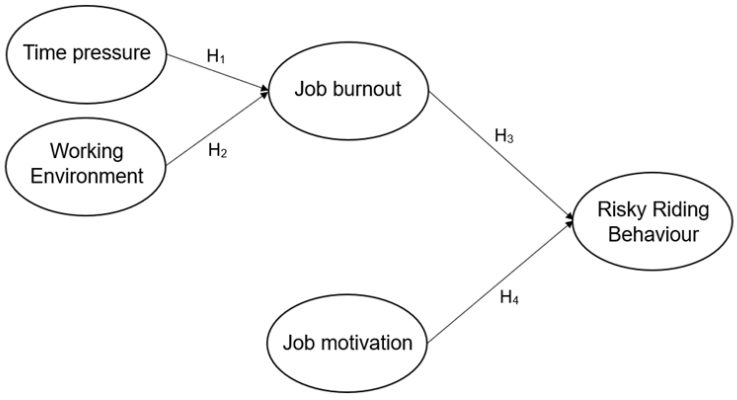

Figure 2 Revised Conceptual Framework

Table 1 Hypothesis Testing

H	Relationship	Beta	Std Error	*t*-value	R^2	Decision
H1	TP → JBO	0.248	0.124	2.655**	0.130	Supported
H2	WE → JBO	0.229	0.162	2.453**	0.130	Supported
H3	JBO → RRB	0.433	0.088	4.579**	0.182	Supported
H4	JMO → RRB	-0.023	0.114	-0.242	0.182	Not Supported

$p < 0.05$* , $p < 0.01$**

Note: TP = Time Pressure; WE = Working Environment; REW = Reward; FEE = Feedback; JBO = Job Burnout; JMO = Job Motivation; RRB = Risky Riding Behaviour

This research used a 95% confidence level to determine whether relationships between variables are significant, and the accepted *t*-value should exceed 1.645 (Hair *et al*., 2017). Time pressure had a positive impact on job burnout ($\beta = 0.248$, $t = 2.655$, $p < 0.01$), thus supporting hypothesis 1. Working environment also showed a positive relationship with job burnout ($\beta = 0.229$, $t = 2.453$, $p < 0.01$), validating hypothesis 2. The *R*2 value for time pressure and working environment was 0.130, indicating that both variables explain job burnout by 13%. Since this research studied on human behaviour, values above 0.1 for *R*2 were acceptable due to the difficulty in predicting human behaviours (Ozili, 2023).

Hypothesis 3 was also supported as job burnout was found to have a positive relationship with risky riding behaviour ($\beta = 0.433$, $t = 4.579$, $p < 0.01$). However, job motivation was not found to be related to risky riding behaviour ($\beta = -0.023$, $t = -0.242$, $p > 0.05$). The *R*2 value was 0.182, indicating that job burnout and job motivation explained risky riding behaviour by 18.2%.

4. DISCUSSION

Time pressure was found having a positive relationship with job burnout. Riders often rush deliveries as there are penalties for not meeting timely deliveries. This finding was similar to Nguyen-Phuoc *et al*. (2024), indicating that burnout among riders was due to delivery time constraints and penalties for late deliveries. There was also a positive relationship between working environment and job burnout. Food delivery riders are frequently exposed to a physically demanding working environment such as intense heat, rain and hazardous road conditions. Unlike cars, riders do not have a vehicle roof to shield them, causing direct weather exposure. This was supported by Truong, Nguyen and Tay (2020), who asserted that motorcyclists are directly exposed to extreme weathers and are constantly manoeuvring the vehicle to maintain stability.

Next, job burnout was found having a positive relationship with risky riding behaviour. This finding suggested that riders who experienced burnout had a higher possibility of engaging in unsafe riding. When riders experience burnout, judgements are impaired. As such, riders would prioritize fast delivery over personal safety. This was supported by Husain, Mohamad and Idris (2019), demonstrating that taxi drivers experiencing fatigue were likely to disregard safe driving practices. Contrary to expectations, job motivation was not related to risky riding behaviour. This suggests that job motivation does not determine whether riders engage in risky riding behaviour. This finding was similarly found where motivation does not necessarily influence unsafe behaviour at work (Tong *et al*., 2019). Nguyen-Phuoc *et al*. (2024) stated that job motivation was more likely to encourage safe riding rather than risky behaviour among food delivery riders.

From this study, it provides theoretical implications whereby it refines the JD-R theory. By identifying how job demands, and job resources contribute to burnout and motivation, which subsequently influence risky riding behaviours, the findings offer a deeper understanding of how work-related factors influence performance outcomes. For practical implications, food delivery companies should impose temporary pauses on the app when riders exceed a certain number of hours. This mitigates potential burnout among riders which could lead to aggressive riding. Government should also

enforce stricter transport policies like license revocation for traffic violators, making riders reconsider their actions before violating traffic laws.

However, it should be acknowledged that there exist several limitations to this study. The relatively small sample size of 105 respondents was the first limitation. Capturing the experiences and behaviours of riders under different conditions may be difficult due to a limited sample size. Another limitation was the variables in this study only managed to explain a small percentage of what food delivery riders are experiencing and how they behave while riding. To tackle the first limitation, future research should increase the sample size to further improve reliability and generalizability of key findings. It should extend beyond Penang to other states such as Selangor, Perak, Johor, etc. For the second limitation, future research should consider adding additional variables like work overload, job autonomy, and work support to further understand the factors affecting risky riding behaviours among food delivery riders.

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Factors That Influence The Employee Awareness on ESG Practices at Warehouses in Penang: A Study Using Organizational Support Theory Approach

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ABSTRACT

This study explores Environmental, Social, and Governance (ESG) awareness among warehouse employees in Penang, Malaysia, through the lens of Organizational Support Theory. It specifically examines the influence of employee training, leadership, recognition systems, and resource availability on ESG awareness. A quantitative method was employed using structured questionnaires distributed to warehouse staff, with data analysed through descriptive statistics, Pearson correlation, and multiple regression. The findings indicate a moderate level of ESG awareness, meaning that while most warehouse employees are somewhat familiar with ESG concepts, their knowledge is basic, attitudes are positive, but practical actions and daily ESG-related behaviours are limited. While employees demonstrate familiarity with ESG principles, deeper understanding and engagement are limited. The results highlight the need for organizations to strengthen internal support mechanisms to promote ESG values more effectively. This study contributes to the growing body of literature on ESG in operational sectors and underscores the role of organizational support in enhancing sustainability awareness among industrial workers.

Keywords: Environmental, Social, and Governance (ESG); ESG Awareness; Warehouse Employees; Organizational Support Theory (OST)

1. INTRODUCTION

Environmental, social, and governance (ESG) concepts have become critical to driving sustainable business initiatives, particularly within supply chains. Logistics operations, especially warehousing, have a considerable impact on environmental performance via emissions, energy use, and trash generation (Błaszczyk and Le Viet-Błaszczyk, 2023). While ESG measures have gained traction in corporate planning, there is still a noticeable lack of awareness at the operational level, particularly among warehouse workers. A lack of ESG awareness among warehouse staff can lead to waste, inefficiencies, and noncompliance with sustainability targets (Leogrande, 2024). Current research has concentrated mainly on transportation sectors, leaving storage, a crucial contributor to logistics emissions, comparatively ignored (Mihova, 2020). This study fills this vacuum by looking into ESG awareness among warehouse workers in Penang, because of its high logistics activity and role as a major industrial and warehousing hub in Malaysia. Drawing on Organisational Support Theory (Eisenberger et al., 1986), the study proposes that perceived organisational support through training, leadership, recognition, and resource availability influences employee awareness and participation with ESG practices. The following hypotheses were developed: (H1) Employee training positively influences ESG awareness, (H2) Leadership support positively influences ESG awareness, (H3) Recognition systems positively influence ESG awareness, and (H4) Resource availability positively influences ESG awareness. The conceptual model positions ESG awareness as the dependent variable and the four organisational support factors as independent variables.

2. METHODOLOGY

This study adopted a quantitative, cross-sectional design to examine factors influencing ESG (Environmental, Social, and Governance) awareness among warehouse employees in Penang. Data were collected using a structured online questionnaire, designed to ensure systematic and reliable responses. The sample was selected through stratified random sampling to represent various job roles, including supervisors, operators, and clerical staff. A total of 90 respondents participated in the survey. The questionnaire consisted of six sections: demographics, ESG awareness, training, leadership, recognition systems, and resource availability. A 5-point Likert scale was used to capture the degree of agreement with each statement. The instrument was adapted from established research (Buhagiar, 2023) and pre-tested in a pilot study to enhance clarity and reliability. Data analysis was conducted using SPSS, applying descriptive statistics, Pearson's correlation, and multiple regression analysis to test the proposed hypotheses and evaluate the relationship between ESG awareness (dependent variable) and the independent variables: training, leadership, recognition systems, and resource availability.

3. ANALYSIS AND RESULTS

Table 1 Profiles of respondents

Demographic Variable	Mean	Standard deviation
Gender	1.60	0.493
Age	2.34	0.656
Education level	2.60	0.761
Job position	1.96	1.027
Years of experience in warehouse industry	2.42	0.936

Multiple regression, Pearson's correlation, and descriptive statistics were used to examine the data gathered from 90 Penang warehouse workers. According to the demographic analysis, the majority of the responded were male, between the ages of 20 and 35, with three to five years of work experience and diploma or degree-level credentials.

Table 2 Reliability Coefficients of the Study Variables

Variables	Original number of items	Number of items utilized after FA and RA	Cronbach's Alpha coefficient
ESG Awareness	5	5	0.884
Training	5	5	0.871
Leadership	5	5	0.905
Recognition System	5	5	0.847
Resource availability	5	5	0.780

The table shows that all study variables have good to excellent reliability based on Cronbach's Alpha values, with Leadership scoring the highest (0.905). Even the lowest score, Resource Availability (0.780), meets the acceptable standard, indicating that all questionnaire items are consistent and reliable for analysis.

Table 3 Pearson's Correlation Analysis of the Study Variables

	Variables	1	2	3	4	5
1	ESG Awareness	1	0.799**	0.631**	0.651**	0.624**
2	Training	0.799**	1	0.718**	0.568**	0.630**
3	Leadership	0.631**	0.718**	1	0.525**	0.579**
4	Recognition System	0.651**	0.568**	0.525**	1	0.653**
5	Resource Availability	0.624**	0.630**	0.579**	0.653**	1

According to correlation analysis, there were strong positive relationships between ESG awareness and the four independent variables of training, leadership, recognition systems, and resource availability. However, the regression analysis showed that the only factors that significantly improved ESG awareness were training and recognition system. This implies that initiatives that promote ESG awareness through hands-on training and recognition are more successful than those that rely solely on resource availability or leadership support.

4. DISCUSSION

According to the results, employee training and recognition programs greatly raise warehouse workers' awareness of ESG issues. This is consistent with earlier research (e.g., Kumar *et al.,* 2023; Choi *et al*., 2024), which emphasises the value of role-specific, hands-on training and incentives to encourage sustainability engagement. However, despite their positive correlation, resource availability and leadership support did not significantly affect employee efforts, indicating that knowledge alone is insufficient in the absence of organised programs and clear recognition of workers' efforts. This study theoretically supports the Organisational Support Theory (OST) by demonstrating that employee attitudes towards ESG are positively influenced by perceived organisational support, especially through training and recognition. Practically speaking, it emphasises how important it is for businesses to put in place organised recognition programs and practical ESG training to promote involvement and sustainable behaviour at the operational level. The study's cross-sectional methodology, concentration on Penang, and dependence on self-reported data, which could introduce bias, are major limitations. Additionally, the consistency of responses may have been impacted by the fact that not all participating organisations had fully implemented ESG procedures. Future research may explore the impact of targeted ESG training on warehouse employees' knowledge and behaviour over time, using a longitudinal analyses or a mixed-methods approach to monitor changes over time. Deeper understanding of ESG implementation in Malaysia's logistics industry may be possible by broadening the study to include other industries or geographical areas and looking at other elements like company culture or governmental legislation.

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Factors Influencing Employee Perception Towards The Adoption of Drone Technology for Last-Mile Delivery in Malaysia

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ABSTRACT

This study explores factors influencing Malaysian logistics employees' perceptions of drone adoption for last-mile delivery using Rogers' Diffusion of Innovation theory. A quantitative survey of 112 employees revealed that relative advantage and observability significantly impact adoption, while compatibility, complexity, and trialability do not. The findings suggest employees are more receptive to drones when the benefits are visible and proven. The study highlights the need for awareness and real-world exposure.

Keywords: Drone Adoption; Last-Mile Delivery; Diffusion of Innovation; Employee Perception; Logistics Technology.

1. INTRODUCTION

As global logistics systems continue to evolve, technological innovations have become crucial in optimizing efficiency and reducing operational costs (Emimi, Khaleel and Alkrash, 2023). Among emerging technologies, drone technology has gained significant attention for its potential in last-mile delivery (LMD) (6Wresearch, 2024), the final leg of the supply chain from warehouse to customer. This stage is often the most expensive and inefficient, accounting for 13–51% of total logistics costs (Ha, Akbari & Au, 2023). Global players such as Amazon, UPS (Jazairy *et al.*, 2024), and DHL (Toraman and Öz, 2023) have piloted drone delivery services, showcasing benefits (Borghetti *et al.*, 2022) such as faster delivery, reduced traffic congestion, and improved access to remote areas (Min, 2023).

Despite these advancements, drone adoption in Malaysia remains limited, even as the logistics sector contributed 3.68% to the national GDP in 2023 (Woon, 2024). This slow uptake is not solely due to technological readiness, but also stems from employee perceptions, acceptance, and concerns about how well drone solutions fit into current systems (Edwards *et al.*, 2024). While the global drone logistics market is growing at a CAGR of 50.1% (MarketsandMarkets, 2023), Malaysia's penetration remains under 5% (Mordor Intelligence, 2024), indicating a clear research gap in understanding local adoption dynamics LMD (Gohari, Ahmad and Oloruntobi, 2023).

To address this, the study explores the factors influencing drone adoption for LMD in Malaysia, specifically from the perspective of logistics employees. Guided by Rogers' Diffusion of Innovation (DOI) theory (Call and Herber, 2022), the study examines how relative advantages, compatibility, complexity, trialability and observability influence innovation adoption.

Accordingly, the research is structured around the following objectives:

RO1: To investigate how relative advantage affects drone adoption for last-mile delivery.
RO2: To determine whether drones are compatible with the logistics industry's present systems.
RO3: To assess how drone adoption is affected by complexity.
RO4: To analyze the role of trialability in the adoption of drones.
RO5: To investigate the effect of observability on the adoption of drones in last-mile delivery.

By applying the DOI framework to the Malaysian context, this study provides a structured understanding of employee readiness and the organisational factors shaping drone adoption.
Based on this framework, the following hypotheses are developed:

Research Framework

This study contributes by addressing a contextual research gap in Malaysia and offers practical implications for logistics firms and policymakers aiming to enhance employee readiness and technological integration in the logistics sector.

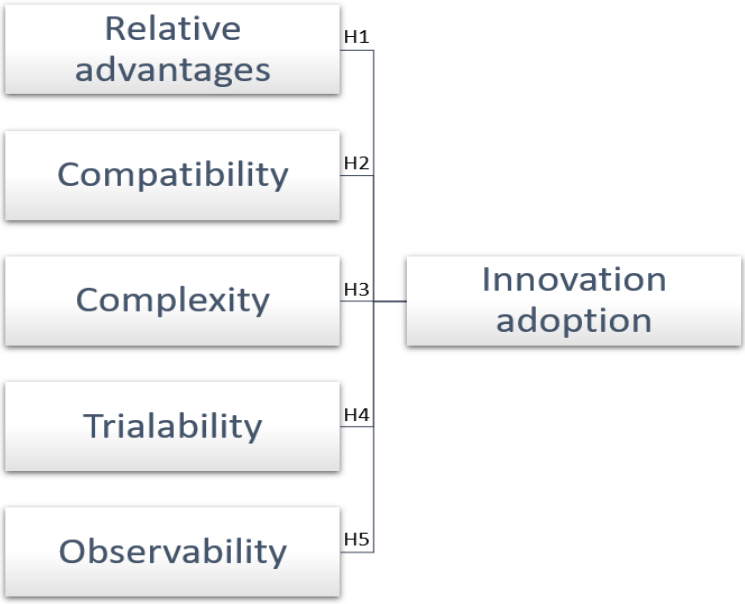

Figure 1 Research model for drone innovation adoption

Based on the conceptual framework, the following hypotheses were formulated:

H1: Relative advantage positively influences the adoption of drones for last-mile delivery.
H2: Compatibility has a positive impact on the adoption of drone technology in last-mile delivery.
H3: Complexity has a significant negative effect on the adoption of drones in last-mile delivery services.
H4: Trialability contributes positively to the adoption of drones for last-mile delivery.
H5: Observability is positively associated with the adoption of drones in last-mile delivery operations.

2. METHODOLOGY

This study used a quantitative, cross-sectional design under a positivist approach, aiming to objectively measure employee perceptions on drone adoption for last-mile delivery (LMD) in Malaysia's logistics sector. The research was guided by Rogers' Diffusion of Innovation (DOI) theory, using a deductive approach to test five proposed hypotheses.

The population included logistics employees in Penang, such as managers, coordinators, technicians, and drivers involved in LMD operations. The unit of analysis was the individual employee. A stratified random sampling method was applied to ensure representation across different job roles. Due to limited data on exact proportions, equal samples were drawn from each group. Based on G*Power calculations, at least 92 respondents were needed to achieve sufficient statistical power.

Data were collected via a Google Forms questionnaire, structured into demographic and DOI-related sections. Each variable, which relative advantage, compatibility, complexity, trialability, observability, and innovation adoption, was measured using five items on a five-point Likert scale. A pre-test improved clarity and instrument validity. Data analysis was conducted using SPSS, employing correlation and multiple regression analyses. Ethical considerations, including informed consent, voluntary participation, and data confidentiality, were strictly followed.

3. ANALYSIS AND RESULTS

Using Pearson correlation analysis, results showed that Relative Advantage ($r = 0.561$), Observability ($r = 0.483$), Compatibility ($r = 0.476$), and Trialability ($r = 0.380$) had positive and significant relationships with innovation adoption. Complexity, however, had no significant impact.

To further explore these relationships, multiple regression analysis was conducted. The model explained 47.6% of the variance in innovation adoption ($R^2 = 0.476$, $F = 19.237$, $p < 0.001$). Only Relative Advantage ($\beta = 0.401$, $p < 0.001$) and Observability ($\beta = 0.287$, $p < 0.001$) significantly predicted adoption. Trialability, Compatibility, and Complexity were not statistically significant.

Hypothesis testing confirmed the importance of Relative Advantage and Observability in driving drone adoption. This implies that organisations are more likely to adopt drones when they see clear benefits and successful examples of use.

In terms of research objectives, only those related to Relative Advantage (RO1) and Observability (RO5) were achieved. The findings suggest that visible benefits and industry success stories are key motivators for adoption, while perceived complexity, compatibility with existing systems, and trial opportunities play lesser roles.

4. DISCUSSION

This study explores the factors influencing Malaysian employees' perceptions of adopting drone technology for last-mile delivery (LMD), using the Diffusion of Innovation (DOI) Theory. Quantitative findings revealed that relative advantage and **o**bservability significantly influence adoption, indicating workers are more receptive when benefits are visible and proven. However, compatibility, complexity, and trialability showed no significant impact, suggesting these factors play a lesser role in shaping employee perceptions.

The study acknowledges limitations, particularly participants' limited knowledge of drone technology, which may affect response accuracy. Future research should target respondents with relevant exposure or provide background context during data collection.

To address research gaps, expert engagement is recommended, allowing scholars to explore overlooked areas such as employee acceptance and regulatory challenges. Lastly, adopting a mixed-methods approach in future studies can offer deeper insights by combining quantitative data with real-world perspectives from interviews or case studies, enhancing both academic value and practical relevance (Garg *et al.*, 2023).

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Relationship Between Transformational Leadership, Safety Climate and Psychological Distress towards Safety Behaviour of Warehouse Employees in Malaysia

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ABSTRACT

A limited understanding of workplace safety can lead to diminished trust in safety leadership, ultimately reducing the effectiveness of safety initiatives within the safety climate framework. To explore this issue, Social Exchange Theory has been applied in this study to assess how transformational leadership, safety climate, and psychological distress influence the safety behaviour of warehouse employees in Malaysia. This research adopts a quantitative approach, utilising a non-probability convenience sampling technique. A total of 212 responses were gathered through a virtual Google Form survey, specifically targeting warehouse employees across Malaysia. The findings revealed that while psychological distress exhibited a weak and negative relationship with safety behaviour, both transformational leadership and safety climate had positive impact on employees' adherence to safety practices. The results indicated that when leaders manifested transformational qualities and cultivated a strong safety culture, employees are more likely to engage in safe behaviours. Additionally, employees experiencing lower levels of psychological distress are more inclined to comply with safety regulations and actively participate in workplace safety measures. This study concludes by providing recommendations for future research, emphasizing the need for further investigation into additional factors that could enhance workplace safety behaviour among warehouse employees in Malaysia.

Keywords: Social Exchange Theory; Transformational Leadership (TL); Psychological Distress (PD); Safety Climate (SC); Safety Behaviour (SB)

1. INTRODUCTION

E-commerce has become essential for online shopping communities, driving a surge in demand for transportation services. However, labour shortages, especially during peak seasons, impact employee productivity and operational efficiency. Extended working hours lead to fatigue, burnout, reduced efficiency, more errors, and lower service quality (Baccichetto *et al*., 2024). Heavy workloads contribute to a rise in occupational injuries. The National Occupational Accident and Disease Statistics in 2022 showed a 35.5% increase in work-related Musculoskeletal Diseases from 2021 (Ismail *et al*., 2024). Manual materials handling (MMH) tasks during order picking pose serious health risks, as movements like pushing, pulling, climbing, lifting, and bending cause tension on the back and shoulders (Lamooki, Cavuoto and Kang, 2022). Low back disorders are common in high-risk environments requiring lifting and awkward postures (Loske *et al*., 2021). Musculoskeletal disorders (MSD) cause discomfort, lower work ability, and lead to more mistakes (Diefenbach, Grosse and Glock, 2024). Thus, ergonomic assessments are essential to create a workplace that supports workers' health (Zhao *et al*., 2022).

The logistics industry in Malaysia plays a crucial role in supporting the movement of goods but faces numerous safety challenges, particularly in transportation, warehousing, and distribution. Poor work

standards, lack of proper protocols, insufficient tools, and limited worker skills increase safety risks, which are worsened by employers' failure to establish safe systems and poor task coordination (Kaur, 2023). A limited understanding of workplace safety also reduces trust in safety leadership, weakening safety initiatives (Ismail *et al*., 2024). Deficiencies in safety management practices further harm organizational safety performance. Although research has explored transformational leadership, safety climate, psychological distress, and safety behaviour in various sectors, only few studies focus specifically on warehouse employees in Malaysia (Binti Ismail *et al*., 2024). This research aims to address that gap.

Homans (1958) defines social exchange as the transfer of material or non-material goods between at least two parties, while Blau (1964) describes it as voluntary actions motivated by anticipated rewards, often reciprocated by others. Emerson (1976) added that social exchange endures if it yields equitable returns. According to Blau (1964) social exchange theory, when employees perceive management's dedication to their safety, they feel obligated to work carefully, influencing organizational safety performance. This responsibility also promotes safety behaviours and strengthens the safety culture (Ajmal *et al*., 2022).

The following hypotheses is presented:

H_1: Transformational leadership influences employee's safety behaviour.

H_2: Psychological distress influences employee's safety behaviour.

H_3: Safety climate influences employee's safety behaviour.

Figure 1 below depicts the research model of the study.

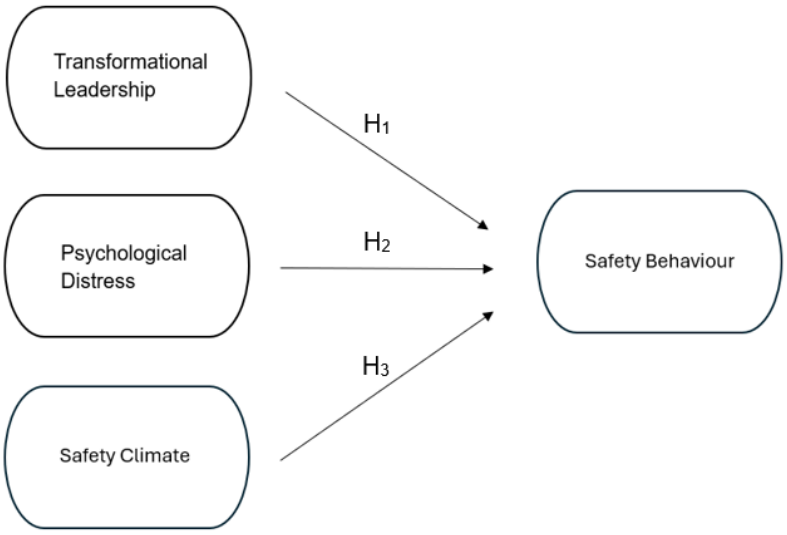

Figure 1 Conceptual Framework

2. METHODOLOGY

A quantitative approach is used to examine the relationship between transformational leadership, safety climate, and psychological distress towards the safety behaviour of warehouse employees in Malaysia. It also employs a cross-sectional approach, where data is collected at a single point in time to address a specific research question (Sekaran and Bougie, 2016). This study uses convenience sampling, which selects samples based on ease of access rather than random selection (Saunders, Lewis, and Thornhill, 2019). Between December 2024 and March 2025, research questionnaires were

distributed via email to managers, supervisors, and personnel from logistics-related departments across various logistics companies in Malaysia. Online questionnaires were distributed to assess the variables examined in this study. The questionnaire consists of five sections, sections A to D cover the dependent and independent variables, while Section E gathers background information about warehouse employees. It includes three questions on safety climate (Ansori *et al*., 2021), ten on transformational leadership (Wang *et al*., 2023), six on psychological distress (Kessler *et al*., 2002), and six on safety behaviour (safety compliance and participation) (Mirza *et al*., 2022). Psychological distress is measured on a five-point Likert scale from 1 (none of the time) to 5 (all of the time), while transformational leadership, safety climate, and safety behaviour are rated from 1 (strongly disagree) to 5 (strongly agree). All the analysis will be completed using Statistical Product and Service Solution (SPSS).

3. ANALYSIS AND RESULTS

A total of 212 warehouse workers participated, with 59.6% male (126 participants) and 40.6% female (86 participants). Most were aged 21-30 (34%) or 51 and above (29.7%). The majority (45.3%) were warehouse operators, followed by other roles (25.5%), supervisors (16%), and managers (13.2%). Most respondents had diplomas (44.8%), with bachelor's degrees (29.7%) being the second-highest qualification. The largest department was "others" (77 participants), followed by inventory (55), inbound operations (33), safety & compliance (24), and outbound operations (23). This study used factor analysis with principal component analysis (PCA), along with the Kaiser-Meyer-Olkin (KMO) test and Bartlett's test of sphericity to assess data suitability. The KMO value for this study was 0.919, indicating excellent suitability for factor analysis. Bartlett's test was significant ($p < 0.001$) with a value of 4839.329, confirming the appropriateness of the data for further analysis. Cronbach's alpha values for the variables in this research are within the reliable range of 0.80 to 1.00 which is classified as a high degree of internal consistency. The correlation matrix indicated that Safety Behaviour (SB) was positively associated with both Transformational Leadership (TL) ($r = 0.672, p < .001$) and Safety Climate (SC) ($r = 0.514, p < .001$) while Psychological Distress (PD) negatively related with SB ($r = -0.238, p < .001$). Furthermore, the independent variables explained 45.7% of the variance in Safety Behaviour which indicated that 54.3% of the variation are unexplained. Table 1 below presents the hypothesis testing results for the variables in this study.

Table 1 Hypothesis testing

H	Relationship	Beta	Std Error	*T* value	R^2	Decision
H_1	TL → SB	0.599	0.072	8.437	0.457	Supported
H_2	PD → SB	-0.029	0.055	-0.540	0.457	*Not Supported*
H_3	SC → SB	0.093	0.093	1.308	0.457	Supported

$p < 0.05$*, $p < 0.01$**

Table 3 revealed that both transformational leadership ($\beta = 0.599, p < 0.001$) and safety climate ($\beta = 0.093, p < 0.10$) were positively related to safety behaviour. Thus, both H_1 and H_3 were supported. Meanwhile, psychological distress ($\beta = -0.029, p > 0.10$) was found not to be related to safety behaviour and therefore, H_2 was not supported.

4. DISCUSSION

The hypothesis structural model in table 3, demonstrates that transformational leadership has a positive impact on warehouse workers' safety behaviour. This finding is consistent with research by Addo and Dartey-Baah (2020) and Wang *et al*. (2023). Moreover, the correlation coefficient in this

study indicates a negative relationship between psychological distress and safety behaviour, which is consistent with findings from Smith *et al*. (2018), Yang *et al*. (2021), and Mirza *et al*. (2022), who reported that job burnout negatively impacts safety behaviour outcomes. Other than that, the results also confirmed that safety climate has a positive impact on the safety behaviour of warehouse employees, aligning with findings from previous research (Hertanto *et al*., 2023; Ajmal *et al*., 2022; Widyanti, 2021).

The sample was limited to warehouse workers, restricting generalizability. Future research should include other sectors like port operations, bunkering, fuelling, and freight management to better understand how transformational leadership, safety climate, and psychological distress affect safety behaviour. The study's limited timeframe prevented inclusion of other influential variables, and the small sample size may reduce statistical power. Additionally, reliance on self-reported data may introduce response bias, as participants' perceptions may not reflect actual practices.

This study shows that various factors influence safety behaviour, offering useful insights for Malaysian warehouse supervisors and managers. However, the range of factors examined was limited. Future research should explore broader predictors such as safety communication, training, personality traits, and co-worker influence. It should also investigate how transformational leadership is mediated by safety motivation and trust (Wang *et al*., 2023; (Enwereuzor, Adeyemi and Onyishi, 2020) and include psychological aspects like occupational stressors, job insecurity, and rewards (Alroomi and Mohamed, 2021; Jung, Lim and Chi, 2020; (Lu *et al*., 2023). Additionally, the findings highlight the need to focus on psychosocial factors alongside physical safety. Organizations should develop a strong psychosocial safety climate (PSC) to support employees' mental health and promote safe practices, especially in high-stress sectors like logistics (Mirza *et al*., 2022). Future research should explore integrated strategies combining psychosocial and physical safety measures to improve overall safety outcomes.

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Advanced Digitalisation in Container Port Operations: Challenges And Opportunities for Implementation at Penang Port

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ABSTRACT

This study examines the challenges and opportunities related to advanced digital technology implementation in container port operations at Penang Port, Malaysia. While digitalisation has revolutionised many ports globally through the Internet of Things (IoT), automation, and artificial intelligence (AI), Penang Port has not fully adopted these technologies, potentially affecting its competitiveness. Through qualitative methods involving semi-structured interviews with seven management-level employees, the research identified three primary themes: (1) digital transformation barriers and implementation challenges, (2) perceived operational value and competitive advantages, and (3) digital vulnerability and system dependency risks. The "readiness amidst resistance" sub-theme revealed coexisting technological openness alongside age-related adaptation challenges and job security concerns. Based on the Technology Acceptance Model (TAM) theoretical framework, the findings showed that geographical positioning is an important contextual factor in shaping the relationship between perceived usefulness and adoption intention. The study provides strategic recommendations including innovative financing models, targeted workforce training programmes, standardised data protocols for terminal integration, and comprehensive cybersecurity frameworks.

Keywords: Advanced digitalisation; Container port operations; Penang Port; Technology Acceptance Model

1. INTRODUCTION

The maritime industry is undergoing a substantial digital transformation, with container ports leading the way. Digitalisation in port operations includes advanced Terminal Operating Systems, automated container handling equipment, blockchain-enabled platforms, and Internet of Things sensors (Heilig, Lalla-Ruiz and Voß, 2017). These digital solutions are recognised to offer enhanced efficiency, optimised resource allocation, and strengthened competitiveness in the global trade sector. Despite the evident advantages of digitalisation in container port operations, Penang Port has not fully embraced digital technologies. While some systems have been introduced, such as the CargoMove Vehicle Booking System (CM VBS) and state-of-the-art container terminal management systems, Penang Port is considered to lag behind other Malaysian counterparts in terms of comprehensive digital integration (MMC Ports, 2023). For instance, the Port of Tanjung Pelepas has successfully integrated AI and automation, while Port Klang is experimenting with AI systems for yard optimisation. This digital gap is recognised as a threat to Penang Port's efficiency, competitiveness, and future growth potential. This research is guided by the Technology Acceptance Model (TAM), which suggests that two core factors—perceived ease of use and perceived usefulness—play a crucial role in the users' acceptance and use of new technology (Davis, 1989). The study aims to identify the main barriers to advanced digital technology adoption in Penang Port's container operations, assess workforce perspectives on digitalisation's impact, and identify perceived risks linked to increased reliance on digital systems.

2. METHODOLOGY

The study employed an interpretivist research philosophy, which prioritises the understanding of subjective meanings and social settings influencing human behaviour (Pervin and Mokhtar, 2022). This approach enabled deep exploration of how port workers conceptualise digitalisation initiatives and their implications. A qualitative research design was selected to examine the complex phenomena surrounding port digitalisation comprehensively. Data was gathered through semi-structured interviews with seven management-level employees from Penang Port, representing diverse operational areas including digitalisation projects, performance improvement, business systems, IT, yard and vessel operations, and engineering. Participants were selected via purposive sampling to ensure relevant expertise, with industry experience ranging from 7 to 25 years. Interviews were conducted online using Zoom and Microsoft Teams platforms according to participants' preferences, lasting between 31 and 67 minutes. All sessions were audio-recorded with participants' consent and later transcribed verbatim. The transcribed interviews were imported into NVivo software for systematic coding and thematic analysis following the six-phase framework proposed by Braun and Clarke (2006).

3. ANALYSIS AND RESULTS

Thematic analysis revealed three primary themes: (1) digital transformation barriers and implementation challenges, (2) perceived operational value and competitive advantages, and (3) digital vulnerability and system dependency risks.

3.1 Digital Transformation Barriers and Implementation Challenges

Financial challenges emerged as the most significant barrier to digital technology adoption at Penang Port. Six out of seven participants highlighted the substantial initial investment required as a major concern. As expressed by one participant: "The direct opinion for me is the high cost of the new technology. That is the main challenge that I see." (P7) This finding confirms earlier research on financial constraints in port digitalisation (Tijan *et al.*, 2021).

Beyond initial investments, participants identified ongoing operational costs as a significant challenge: "So, for the operational costs advance, that means for the challenges for the operational and maintenance costs. It must proceed with the advanced technology; it also requires ongoing costs such as software updates, system maintenance, cybersecurity and technical support." (P6)

Workforce resistance emerged as a complex theme with significant nuance. The analysis revealed that resistance was not uniform across the organisation but varied according to factors such as age, position, and perceived job security. As one participant explained: "For people at a certain age, if they're over a certain age, it's difficult for them to adapt. So that's where I see the challenges." (P3)

Despite these challenges, analysis of responses also revealed a surprising level of technological readiness within the organisation. Multiple participants noted positive attitudes toward technology adoption. This suggests that resistance, while present, may not be as pervasive as literature often predicts for port environments. P1 stated: "Employee and management at Penang port have demonstrated so far... they are demonstrating increasing openness towards adopting new technology." (P1)

Technical integration challenges represented significant barriers to implementation, especially given Penang Port's fragmented terminal layout: "The challenges that I foresee we have here in Penang port

is that our terminal is scattered. So, if you look at the installation of Penang Port itself, we have almost seven terminals." (P3)

This fragmented terminal layout creates additional integration complexities: "At Penang Port, we have a lot of terminals, and to integrate all of them into one centralised system is very challenging." (P3)

3.2 Perceived Operational Value and Competitive Advantages

Operational efficiency and cost optimisation emerged as primary perceived benefits of advanced digitalisation at Penang Port. Analysis of participant responses revealed specific expectations regarding efficiency gains, including reduced vessel turnaround time, streamlined cargo handling, and optimised resource allocation. One participant stated: "For example, we have a haulier turnover. Haulier turnover means the period from when they enter until they exit. So, we can reduce the turnover time." (P7)

Error reduction and automation benefits were highlighted as significant advantages, with participants noting how automation can simultaneously improve operational precision and safety: "You can reduce accidents from happening because you automate your system (...) You don't expose your people (...) to the risk of the accident (...) because you automate things." (P3)

Interestingly, there was significant divergence among participants regarding digitalisation's impact on Penang Port's competitive position. Analysis showed a range of viewpoints, ranging from those who viewed technology as critical for competitiveness to those who believed Penang Port's geographic position diminished the immediate competitive necessity of digitalisation. P4 argued: "Because Penang port is behind, (...) no OCR [Optical Character Recognition] implemented yet compared to other ports. (...) it's quite challenging to catch up." (P4)

In direct contrast, other participants emphasised geographical positioning as the primary competitive determinant: "The competitiveness is not about who got the better technology or AI. Our competitiveness based on the service offered here. For the northern region, we are the only port in the northern region. So, the container and vessel connectivity are through Penang port." (P5)

Analysis of these contrasting perspectives reveals fundamentally different conceptualisations of port competitiveness. Some participants evaluate competitiveness through benchmark comparisons with other ports, while others emphasise geographical market positioning as the primary competitive factor. This finding reflects the complex reality of port competition, which differs significantly from typical market competition due to geographical constraints and network effects.

A more nuanced perspective was offered that acknowledges both short-term and long-term competitive dynamics: "As global trade dynamics evolve (...) ports that lack in digital transformation may find themselves at disadvantages in meeting the growing demand for integrated data-driven logistic solution." (P1)

3.3 Digital Vulnerability and System Dependency Risks

Participants expressed significant concerns about cybersecurity threats and data protection risks associated with increased digitalisation. P1 highlighted: "The potential threats include ransom attacks, data breaches, phishing attempts and malware infiltrations targeting the critical infrastructure." (P1) These risks were not merely theoretical; P4 reported that: "We have monitored the certain IP from

Russia, from Israel to block the IP. (...) we have experiences on virus by email (...) from Russia, from Israel." (P4)

Additionally, concerns about system failures and the resulting operational disruptions emerged as a key risk. P2 noted that: "(...) when handling containers daily, we are handling daily about 2,000 containers. When the system failure, the manual will come in. (...) the error to misplace the container is very high." (P2)

4. DISCUSSION

The findings from this study largely confirm the applicability of the Technology Acceptance Model (TAM) in the maritime port context while revealing more nuanced relationships between key variables. As proposed by Davis (1989), Perceived Usefulness and Perceived Ease of Use

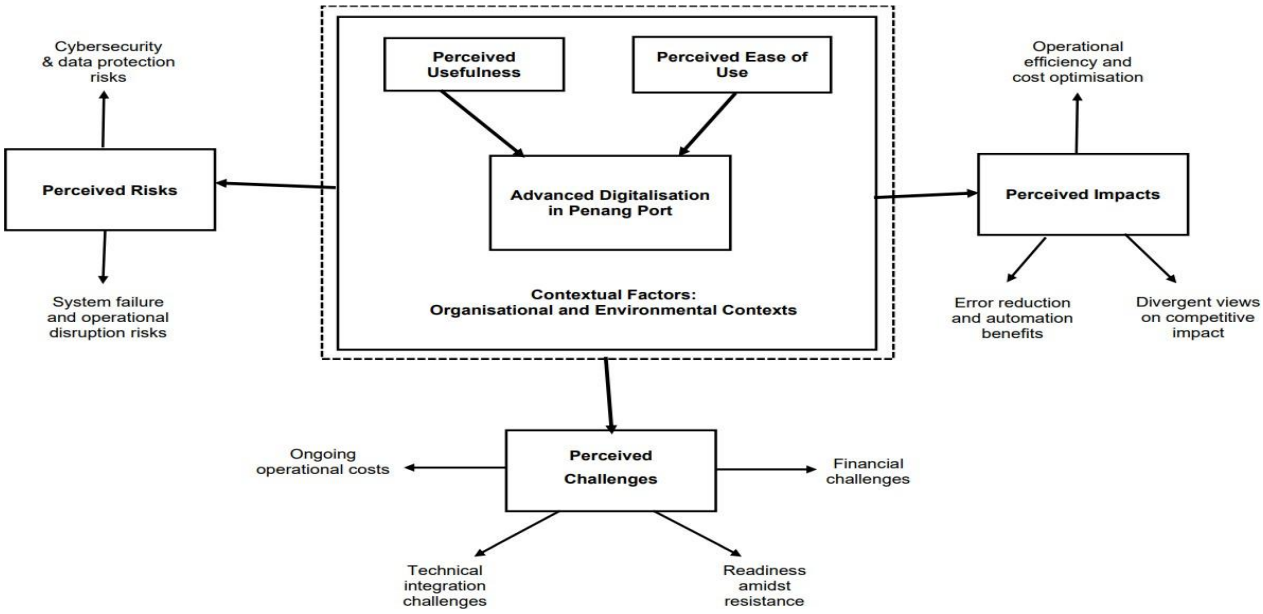

Figure 1 Conceptual framework for advanced digitalisation in Penang Port.

demonstrated clear influence on attitudes towards advanced digitalisation at Penang Port. However, the data revealed that these perceptions are significantly mediated by unique organisational and environmental contexts specific to the maritime industry. The findings extend Yang (2019) research by demonstrating how geographical positioning moderates the relationship between perceived usefulness and adoption intention. This was evidenced by participant P5's observation that "The competitiveness is not about who got the better technology or AI. Our competitiveness based on the service offered here," suggesting that standard TAM applications may not fully capture port-specific dynamics.

Financial challenges emerged as the most significant barrier to technology adoption, supporting Tijan *et al.* (2021) assertions regarding financial constraints. However, the results distinguish between initial investment barriers and sustained operational costs, suggesting a more granular understanding of financial challenges than previously documented in the literature.

The complex relationship between workforce resistance and technology adoption revealed significant variation based on age, position, and perceived job security. While this supports Chiarini *et al.* (2023) findings, this research adds important nuance by identifying the coexistence of both resistance and

readiness within the same organisational environment, suggesting that resistance is not uniform across workforce segments.

The strong alignment between advanced digitalisation and operational efficiency confirms Gattuso and Pellicanò (2023) findings on productivity improvements in digitalised ports. However, the divergent views on competitive impact necessitate reconsideration of conventional technology adoption models that assume competitive advantage as a primary driver, expanding upon Arnlund and Wahl (2021) research on port-specific external factors.

From a theoretical perspective, this study contributes to technology adoption literature by demonstrating that while TAM provides a useful foundation for understanding technology adoption in port settings, port-specific factors require integration into existing models. The findings suggest that geographical positioning, terminal layout complexity, and temporal considerations significantly moderate relationships between key TAM variables in ways not fully captured by standard applications of the model. This necessitates refinement of technology adoption frameworks to incorporate these maritime-specific contextual factors.

Practical implications from this research include the need for innovative financing models such as public-private partnerships, targeted workforce training programmes addressing specific demographic concerns, and comprehensive cybersecurity frameworks to mitigate increasing digital vulnerability risks. Additionally, the divergent views on competitive impact necessitate the development of strategic approaches that balance geographical advantages with technological capabilities.

Based on the analysis, several strategic recommendations emerge for Penang Port: (1) explore innovative financing models such as public-private partnerships to distribute the initial investment burden, (2) implement targeted training programmes tailored to different workforce segments, (3) develop standardised data protocols for seamless integration across terminals, and (4) invest in robust cybersecurity infrastructure with regular vulnerability assessments.

This study has several limitations. The sample of seven management-level employees may not represent the full range of perspectives within Penang Port. The exclusion of operational staff and external stakeholders like shipping lines and logistics providers limits the comprehensiveness of findings. Additionally, focusing solely on Penang Port may restrict the generalisability of findings to ports with different operational contexts. Future research should address these limitations through larger-scale studies incorporating perspectives from various organisational levels and external stakeholders. Comparative studies examining digitalisation across multiple Malaysian ports would better contextualise Penang Port's experience within broader national trends. Quantitative studies could validate these findings through standardised surveys across ports, identifying significant patterns to strengthen national port digitalisation policies.

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Does Commitment Increase Service Performance Among E-Hailing Providers?

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ABSTRACT

This study investigates the impact of commitment on service performance within the context of e-hailing services providers. Grounded in Social Exchange Theory (SET), the research explores how interpersonal and organizational relationships influence overall service effectiveness. A quantitative approach was employed, utilizing surveys to gather data from service providers and customers. The study highlights the need to improve commitment in order to enhance service outcomes. Despite limitations related to self-reported data and geographic scope, the research provides valuable insights for businesses, organizations, and future scholars. Recommendations include long-term engagement strategies, technological integration, and comparative studies across industries and cultural contexts to further validate and expand upon these findings.

Keywords: Commitment; E-hailing; Service performance; Social Exchange Theory

1. INTRODUCTION

1.1 Background of the Study

The rapid growth of technology has significantly impacted business operations, particularly in the transportation industry, leading to the rise of e-hailing services. These services, such as Grab Car, MULA, Maxim, and Lalamove, are popular due to their accessibility, reasonable pricing, convenient payment methods, and transparent driver details (Ubaidillah et al., 2019). In Malaysia, e-hailing services cater to the growing demand for flexible travel, with a projected revenue increase of RM 2.27 billion by 2024, growing at an annual rate of 3.5% through 2029 (Statista, 2024). However, challenges related to driver commitment continue to affect the industry's expansion.

1.2 Problem Statement

The rapid growth of the e-hailing industry has improved transportation convenience, particularly in areas with limited access to public transport (Windasari, Uzzi, & Satoto, 2017). Services such as standard rides, luxury vehicle hires, and delivery options like food and parcel deliveries are widely offered through platforms like Grab Car, Grab Food, and J&T Express (Al-Shakhrit, Masri, & Othman, 2021; Chai & Yat, 2019). However, rising usage has led to increasing expectations for service quality, accompanied by a surge in complaints related to driver commitment. For instance, an incident at J&T Express in Perak highlighted employee dissatisfaction over unfair payment structures, which led to violent package handling and exposed the consequences of deteriorating organisational commitment (The Vibes, 2021). Furthermore, Malaysian e-hailing drivers have voiced concerns over an unfair fare system, poor compensation, and limited support from service providers, all of which affect motivation and service performance (Shahirah, 2024). These ongoing issues challenge the sustainability and effectiveness of the e-hailing industry in Malaysia.

1.2 Underlying Theory

Social Exchange Theory (SET), as introduced by Blau (1964), explains how individuals form and maintain relationships based on reciprocal exchanges of social and emotional resources. Ahmad et al.

(2023) outlined three core stages: an action is initiated, followed by a relational response, and finally, a behavioral response that forms the foundation of a relationship. Reciprocity—the act of giving and receiving benefits—is essential (Cropanzano et al., 2017). Organizations often initiate exchanges that influence employees' perceptions and responses (Wu et al., 2021). Commitment is also vital: commitment reflects the intent to maintain long-term relationships (Chernyak-Hai & Rabenu, 2018).

1.3 Hypotheses Development

Employee commitment, which encompasses dedication, motivation, and alignment with organizational goals, plays a crucial role in shaping service quality. Committed employees, including drivers in the e-hailing sector, are more likely to exhibit professional behavior, maintain punctuality, and uphold service standards (Estigoy & Sulasula, 2020). When organizations provide career development opportunities, fair incentives, and recognition, employee commitment strengthens. This not only reduces turnover but also enhances customer satisfaction and trust (Heydari & Lai, 2019). Research by Lo et al. (2024) supports the view that high commitment contributes to better customer experiences and long-term organizational success. Thus, commitment is expected to positively influence service performance.

H1: Commitment is positively related to service performance.

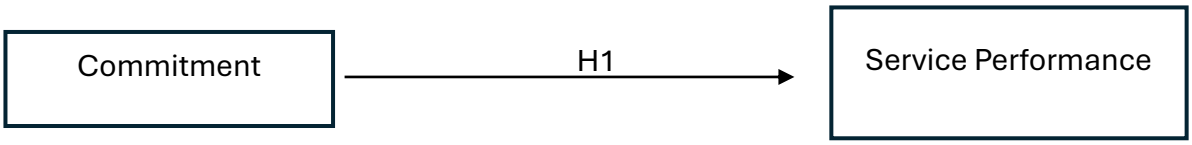

Figure 1 Framework Diagram

2. METHODOLOGY

2.1 Research Design

Research design is a strategy or plan designed to address the research questions through measurement, data collection, and analysis (Sekaran & Bougie, 2016). Quantitative research refers as the process of collecting and analysing data. It used to identify averages and patterns, test causal relationships, and project the results to larger populations (Bhandari, 2022). Cross-sectional is a study that is conducted in which data is just obtained once, over a period of days, weeks, or months, in order to address the research. This study will use a quantitative cross-sectional research design. Besides, this research relied on questionnaires created on google form and delivered to the target respondent.

2.2 Sampling Technique

Purposive sampling is a group of non-probability sampling techniques which target respondents are selected because it got the characteristics that are needed in sampling (Nikolopoulou, 2022). In other words, target respondents are selected purposely in purposive sampling. Non-probability sampling is a method of selecting respondents from a population using a subjective method (Statistics Canada, 2021).

This technique is supported to imply in this research as it is assured that only the e-hailing driver and rider in Malaysia are involved in the research. Besides, this research purposely chooses to focus on Penang, Malaysia only for the data collection, hence this increases the validity of the research outcome.

2.3 Data Collection Procedure

The questionnaire was designed to target all e-hailing drivers and riders across Malaysia and was

created using Google Forms. To collect responses, the researcher visited various locations where e-hailing activities are commonly observed. These included drop-off and pick-up points at hotels and shopping malls, where the presence of e-hailing drivers is frequent. In addition, the researcher approached riders at food outlets that partner with e-hailing delivery platforms. Questionnaire distribution primarily took place during the afternoon, a peak period for food deliveries at fast-food outlets in shopping malls. During these visits, the researcher shared the Google Form link directly with drivers and riders after obtaining their consent to participate. This ensured that all respondents willingly and voluntarily contributed to the study.

2.4 Research Instruments

Commitment was measured with three items adapted from Nyaga and Whipple (2011) as shown in Table 1 below. On the other hand, performance was measured by asking the respondent their star rating rated by their customers.

Table 1 Measurement item for commitment

Variable	Question	Reference
Commitment	Q1: I expect this relationship to continue for a long time. Q2: I am committed to this e-hailing company. Q3: I expect this relationship to strengthen over time.	(Nyaga and Whipple, 2011) α= 0.92

3. ANALYSIS AND RESULTS

The data collected were subjected to descriptive analysis, reliability analysis and regression analysis. The demographic analysis revealed that the majority of the respondents were male (76.8%), Chinese (57.3%) and single (not married) (61%). The mean age of the respondent was 31.27 and the mean tenure of providing the e-hailing services was 3.5 years.

With regards to reliability, the Cronbach's alpha for commitment was 0.871. It shows that commitment is a reliable measurement. Next, the two variables were tested for regression. As shown in Table 2 below, commitment was shown to be positively related to performance ($\beta = 0.08$, $p < 0.05$).

Table 2 Regression Analysis for Performance

Hypothesis	Standardised beta	*t* value	*p* value	Decision
H1: COM→PERF	0.308	2.208	0.015	Supported

Note: $p^{**} < 0.01$(two-tailed)

This means that drivers or riders who are more committed to their e-hailing company tend to get better performance for the company, highlighting the importance of long-term dedication in driving success

4. DISCUSSION

The results of this study provide important insights into the relationship between commitment and service performance, particularly within the e-hailing industry. In interpreting the findings, it was revealed that commitment positively influences service performance, aligning with prior research (Estigoy & Sulasula, 2020; Heydari & Lai, 2019; Lo et al., 2024) that highlights the importance of employee engagement and long-term attachment in improving service outcomes.

From a theoretical perspective, the study contributes to the application of Social Exchange Theory in the e-hailing context. Practically, the findings highlight the need for organizations to prioritize strategies that build employee commitment, such as career development opportunities, consistent engagement, and benefit schemes.

This study is not without limitations. The reliance on self-reported data raises concerns about potential response bias. The limited geographic scope and use of a cross-sectional design also restrict the generalizability and ability to observe changes over time. Additionally, the lack of industry diversity further narrows the applicability of the findings.

Future research should broaden its scope by including diverse service industries and geographical contexts, while also adopting longitudinal designs to track how commitment evolves and impact service performance over time. Investigating factors like leadership style, CSR practices, and psychological influences on employee behavior would further enrich the understanding of what drives high service performance in dynamic service environments.

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The Relationship Between Commitment and Promotion Behaviour Among Student Residents

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ABSTRACT

This study examines the relationship between commitment and promotion behaviour among student residents from institutions of higher learning. Data was collected from 160 respondents who are staying at student residents within institutions of higher learning in Malaysia and the data was analysed using SPSS. Results indicated a positive relationship between commitment and promotion behaviour. The finding suggests that it is important for institutions of higher learning to cultivate commitment among residents towards the residence to increase promotion behaviour to increase revenue for the residence. Theoretically, the finding adds further knowledge to the social exchange theory as well as to the empirical literature on both commitment and promotion behaviour in the context of student residence.

Keywords: Commitment; Institutions of higher learning; Promotion behaviour; Student residence

1. INTRODUCTION

University residences function not only as housing but also as communities where students establish social networks, participate in academic collaboration, and foster independence (Olanrewaju *et al.*, 2022). Such optimal living environment greatly impacts students propensity to engage in community-oriented activities. In emerging higher education markets, emotional attachment to campus environments are closely linked to students' willingness to exhibit citizenship behaviours (Sharif and Lemine, 2024).

In Asia, the swift expansion of higher education has heightened the demand for quality student accommodation; however, ongoing disparities in housing infrastructure, regulation, and funding continue to pose significant challenges. Malaysia has become a prominent regional centre for international students; however, universities face challenges in accommodating rising demands due to spatial limitations, variable standards, and dependence on public-private partnerships (Ghani *et al.*, 2020).

With the private higher education becoming more competitive in Malaysia (Ahmad *et al.*, 2022), it is important for students to play a role in promoting the institutions of higher learning. Hence, there is a need to examine the relationship between commitment and promotion behaviour in the context of private higher education.

Guan *et al.* (2022) has demonstrated the application of social exchange theory among consumers who reciprocated to the business when their needs are fulfilled. Based on the premise of social exchange theory, this study hypothesised that there is a positive relationship between commitment and promotion behaviour. Van Tonder and Petzer (2020) showed that affective commitment is positively related to advocacy behaviour in ride sharing platforms, meaning to say that consumers who are affectively commitment to the platform are more likely to promote that service to other consumers. The research model is shown in Figure 1 below.

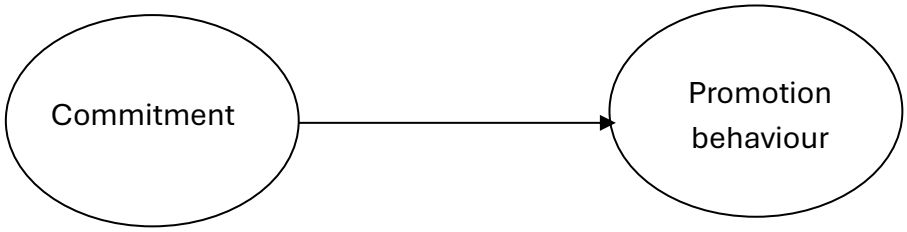

Figure 1 Research model

2. METHODOLOGY

This research employs positivism and deductive reasoning in its methodology. Using quantitative method, the research relies on survey method to collect data from respondents. A total of 160 respondents were collected purposively from students staying at student residents through online questionnaires. The data were analysed using descriptive analysis, factor analysis, reliability analysis and regression analysis by relying on the SPSS software.

A 5-point Likert scale for commitment was adapted from Choi and Lotz (2018) and it was measured with three items. On the other hand, promotion behaviour was also adapted from Choi and Lotz (2018) and it was measured with a 5-point Likert scale containing three items as well. The composite reliability reported were 0.931 and 0.925 respectively (Choi and Lotz, 2018).

3. ANALYSIS AND RESULTS

Data collected were analysed using descriptive statistics and it showed that the majority of the respondents were female (64.4%), were between 17 and 20 years old (62.9%), and Chinese (69.2%).

To test for validity, the data were subjected to factor analysis and it showed that the two variables, commitment and promotion behaviour, were distinct and separate. The results are shown in Table 1 below.

Table 1 Factor loadings of variables

Items	Components	
	Commitment	Promotion behaviour
C1	0.812	0.336
C2	0.868	0.255
C3	0.865	0.063
C4	0.643	0.570
C5	0.753	0.392
PB1	0.250	0.875
PB2	0.148	0.915
PB3	0.339	0.802
Eigenvalues	4.971	1.275
Total variance explained	41.748	36.32
KMO	0.873	
Bartlett's Test of Sphericity	906.330	

The Cronbach's alpha for commitment and promotion behaviour were 0.907 and 0.890 signifying that the measurement is reliable.

With the measurement for both variables being shown to be valid and reliable, the regression test was performed. As shown in Table 2, the result signified that commitment was positively ($\beta = 0.601$, $p < 0.001$) related to promotion behaviour.

Table 2 Hypothesis Result

Hypotheses	Beta	Standard error	*t* value	Decision
Commitment → Promotion behaviour	0.601	0.070	9.424	Supported

4. DISCUSSION

The findings revealed that commitment is an important determinant of promotion behaviour among student residence in higher education institutions, supporting a previous study by van Tonder and Petzer (2020). The finding also supported the social exchange theory. The findings of the current study implies that residents who are committed to the residence are more likely to promote the residence to other customers.

Theoretically, the finding extends the social exchange theory in the context of student residence and also contributing to the empirical literature on the relationship between commitment and promotion behaviour. Practically, the finding suggests that it is important to cultivate commitment among the residence to help promote the residence to other potential customers to the benefit of the institutions because it helps increase the revenue of the residence.

One particular limitation of this study is that non-probabilistic sampling was used for data collection which limited the generalisation of the finding. Future research may consider using probabilistic sampling to ensure the findings can be generalised.

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Predictors of Continuance Intention to Use E-Wallet

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ABSTRACT

With the advent of advance technology, financial technology particularly digital payment has become phenomenon around the world. This study objective is to study the continuance intention to use e-wallet in Malaysia. This research provides a better understanding on the key factors to e-wallet usage. To integrate e-wallet continuance intention, the unified theory of acceptance and use of technology (UTAUT) and government support were utilized. This study examined the relationship between e-wallet continuance intention and four main variables. This study applied quantitative research method which survey was distributed to 155 participants but only 141 were valid respondents. Partial least squares structural equation modelling (PLS-SEM) via SmartPLS 3 was used to analyse the data collected from 141 respondents who were e-wallet users in Malaysia. The result revealed that performance expectancy, social influence and facilitating condition had significant effect on the continuance intention to use e-wallet. Furthermore, this research found significant effect of government support on the performance expectancy. Due to the data was collected mainly from Malaysia, hence the generalisability of the findings was limited. Besides, the small sample size also limited the opportunity of generalization of the findings. This research findings provides guidelines for effective development of e-wallet platform and support that needed to influence Malaysian to use e-wallet continuously. This study contributed by closing gap of understanding from existing studies by integrating UTAUT and government support. This theory derived from theoretically integrated framework that could be applied to study the continuance intention to use e-wallet from the context of developing countries such as Malaysia.

Keywords: Continuance intention; E-wallet; UTAUT; Government support

1. INTRODUCTION

1.1 Background of the study

The rise of the Fourth Industrial Revolution and government initiatives like the National 4IR Policy have driven Malaysia toward becoming a digital and cashless society (World Economic Forum, 2022). This policy complements with Malaysia Digital Economy Blueprint (TheStar, 2021) E-wallet usage surged during the COVID-19 pandemic due to the need for contactless payments (Birruntha, 2021). This study explores what influences users to continue using e-wallets after initial adoption.

1.2 Problem Statement

While many Malaysians have adopted e-wallets, not all continue using them regularly. Most existing studies focus on initial adoption, with limited attention to continuance behavior, especially in Malaysia. Additionally, the role of government support in sustaining e-wallet usage remains underexplored. This lack of comprehensive analysis hinders stakeholders' ability to formulate effective strategies that drive long-term user engagement. Thus, there is a critical need to identify the key determinants that influence Malaysian users' intention to continuously use e-wallets, particularly by considering local demographic profiles and technological, social, and institutional factors.
This study addresses the gaps by examining factors influencing continuance intention.

1.3 Underlying Theory

The study uses the Unified Theory of Acceptance and Use of Technology (UTAUT), which includes performance expectancy, effort expectancy, social influence, and facilitating conditions (Puasa et al., 2021). To better reflect the Malaysian context, government support is added as an external factor. This extended model aims to provide a more comprehensive view of long-term e-wallet usage.

1.4 Hypotheses Development

Based on the extended UTAUT model, the study proposes the following hypotheses:

- H1: Performance expectancy positively affects continuance intention.
- H2: Effort expectancy positively affects continuance intention.
- H3: Social influence positively affects continuance intention.
- H4: Facilitating conditions positively affect continuance intention.
- H5: Government support positively affects performance expectancy.

These hypotheses examine both individual and external factors that influence continued e-wallet use in Malaysia.

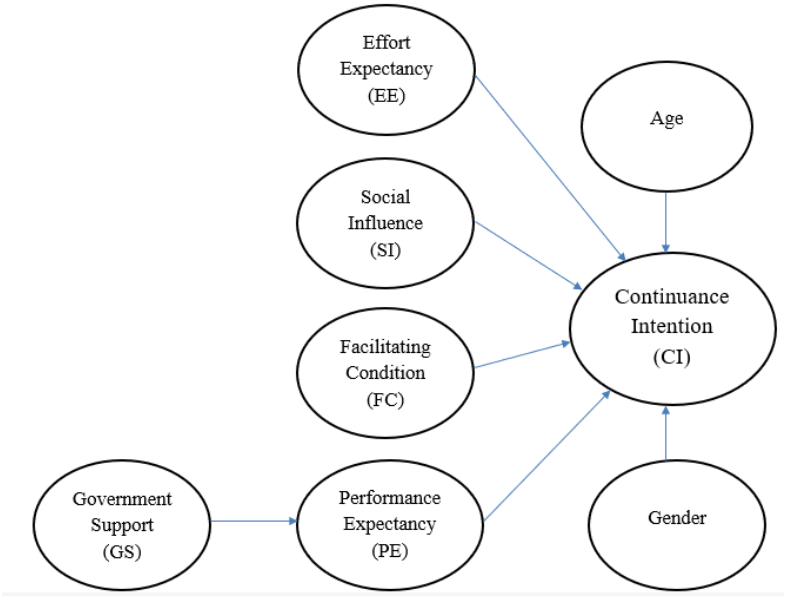

Figure 2 Research Model

2. METHODOLOGY

2.1 Research design

This study adopted a positivist philosophy with a deductive approach, applying a mono-method quantitative research design (Bell et al., 2015). Data was collected using a structured online survey to understand the continuance intention of e-wallet usage in Malaysia. A cross-sectional time horizon was used, meaning data was collected at one specific point in time to capture a snapshot of user behavior and perceptions. All the responses were collected over a span of one-and-a-half months. As a result, a total of 155 online responses were collected but only 141 responses were eligible for statistical analysis as 14 responses were removed due to not fulfilling the screening question criteria.

2.2 Sampling technique

A non-probability purposive sampling was employed to conduct this study. This method was chosen to ensure participants met the specific criteria of being active e-wallet users, which aligns with the research objectives (Bell et al., 2015). A screening question was included at the beginning of the

online questionnaire to ensure the respondents were under the qualifying criteria of being the current e-wallet users in Malaysia.

2.3 Data collection procedure

Data collection was conducted through online self-administered questionnaires distributed via Google Forms. The survey link was shared across social media platforms such as WhatsApp, Instagram, and Facebook. A pilot test was conducted beforehand to ensure clarity and validity of the instrument. The data collection spanned approximately one and a half months, using a screening question to filter out non-users.

2.4 Research instruments

The questionnaire consisted of 32 items, segmented into seven sections that measured the constructs of the UTAUT model and government support. All items were adapted from validated sources in previous literature, and measured using a 5-point Likert scale. Demographic data were also collected using nominal, ordinal, and interval scales, ensuring comprehensive profiling of respondents.

2.5 Statistical Analysis

The data were analyzed using Partial Least Squares Structural Equation Modelling (PLS-SEM) with SmartPLS 3 software. This method was selected due to its suitability for complex models and smaller sample sizes. The analysis included measurement model evaluation, structural model assessment, and hypothesis testing using bootstrapping (5,000 samples), as well as checks for common method bias, multicollinearity, and predictive relevance.

3. ANALYSIS AND RESULTS

The analysis was conducted on data collected from 141 valid e-wallet users in Malaysia. The measurement model demonstrated satisfactory reliability and validity, with all constructs meeting the thresholds for composite reliability, average variance extracted (AVE), and discriminant validity. Structural model evaluation revealed that performance expectancy ($\beta = 0.398$, $p < 0.001$), social influence ($\beta = 0.189$, $p < 0.01$), and facilitating conditions ($\beta = 0.346$, $p < 0.001$) had significant positive effects on continuance intention to use e-wallets, supporting Hypotheses H1, H3, and H4 respectively. Government support was also found to significantly influence performance expectancy ($\beta = 0.415$, $p < 0.001$), supporting H5. However, effort expectancy did not show a significant relationship with continuance intention ($\beta = 0.005$, $p > 0.05$), thus rejecting H2. The model explained 67.2% of the variance in continuance intention and 17.2% in performance expectancy, indicating substantial and moderate predictive power respectively. Additionally, gender was found to have a significant effect on continuance intention, with males showing a higher likelihood of continued use, while age did not significantly impact user intention.

Table 1 Results for direct effect

Hypothesis	Beta	Standard error	t-value	95% confidence interval	f^2	Decision
H1 PE → CI	0.398	0.084	4.720***	[0.268, 0.545]	0.219	Supported
H2 EE → CI	0.005	0.093	0.058	[-0.146,0.159]	0.000	Not supported
H3 SI → CI	0.189	0.066	2.863**	[0.084,0.297]	0.077	Supported
H4 FC → CI	0.346	0.093	3.712***	[0.192,0.496]	0.137	Supported
H5 GS → PE	0.415	0.068	6.129***	[0.284,0.510]	0.208	Supported

Note(s): *p < 0.05; **p< 0.01 (one tailed); ***p<0.001; PE = performance expectancy; EE = effort expectancy; SI = social influence; FC = facilitating conditions; GS = government support; CI = continuance intention

4. DISCUSSION

4.1 Interpretation of the results in relation to past findings

The results show that performance expectancy, social influence, and facilitating conditions significantly influence the continuance intention to use e-wallets, aligning with findings from past studies (e.g., Saraswati et al., 2021; Indrawati & Putri, 2018). Interestingly, effort expectancy was not significant, which contradicts the UTAUT model but is supported by some recent research suggesting that ease of use may no longer be a concern for users already familiar with the technology. Government support was also found to positively affect performance expectancy.

4.2 Theoretical and Practical Implications

Theoretically, the study contributes to existing literature by extending the UTAUT model to include government support, offering a more holistic understanding of e-wallet continuance in a developing country context. It confirms that institutional factors can indirectly influence behavioral intentions through user perceptions.

Practically, the findings provide insights for e-wallet providers and policymakers. Developers should focus on improving system performance and support infrastructure, while the government should continue providing incentives, secure frameworks, and awareness campaigns to build user trust and engagement.

4.3 Limitations

The study has several limitations. The sample was collected primarily from users in northern Malaysia, limiting the generalizability to the entire population. Additionally, most respondents were young (21–30 years old) and many were students, which may not reflect older or more diverse demographics. The use of a cross-sectional design also restricts understanding of how user intentions may evolve over time.

4.4 Suggestions for Future Research

Future studies should include a more geographically and demographically diverse sample to better represent Malaysian e-wallet users. Incorporating longitudinal data would help track changes in user behavior over time. Researchers are also encouraged to explore other influencing factors such as income and education background, and consider using UTAUT2, which includes additional constructs like hedonic motivation and price-saving orientation for a more comprehensive analysis (Indrawati and Putri , 2018).

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The Impact of Singapore Port Just in Time (JIT) Implementation on Malaysia Seaport Operational Efficiency

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ABSTRACT

The adoption of just-in-time (JIT) platforms in Singapore ports has affected the operational efficiency of Southeast Asian ports, particularly in Malaysia as a neighbouring country. This study analyses the extent to which Singapore's JIT practices have influenced Malaysian ports in terms of operational changes and corporate strategic responses. Employing quantitative research methods rooted in interpretivism, the study explores three key operational themes: infrastructure development, technological transformation and operational flexibility to demonstrate how Malaysian ports have adapted, survived and grown. The results of the study show that Malaysian ports such as Port Klang, Port of Tanjung Pelepas (PTP) and Penang Port have invested heavily in automation, digitisation and customs efficiency, but limitations still exist. Specifically, the port limitations are infrastructure constraints, delays in automation adoption coupled with the implementation of JIT platforms will have negative impacts on the port, such as increased congestion. In order to improve competitiveness, this study recommends that ports prioritise investment in automated crane (AC) systems, as well as the use of AI and blockchain, and that intermodal networks be strengthened to develop better regional connectivity. These recommendations aim to make Malaysian seaports more JIT-compliant, leading to faster cargo movement, shorter turnaround times, and improved connectivity to global trade networks. This study ultimately suggests that continued modernisation of ports is imperative, while policies should be prioritised to make Malaysian ports important hubs in the changing maritime logistics landscape.

Keywords: Just-in-time(JIT); Seaport Operational Efficiency

1. INTRODUCTION

1.1 Background

Maritime transport plays a crucial role in global trade, carrying around 80% of international commerce by volume. According to the United Nations' Review of Maritime Transport report, global seaborne trade reached 12,292 million tonnes in 2023, a 2.4% increase from the previous year (Development, 2024). Containerised shipping enhances maritime logistics by enabling efficient handling of standardized cargo units (Christiansen et al., 2007). Ports like Singapore, Port Klang, and Port of Tanjung Pelepas have become key transshipment hubs due to their strategic positions along the Straits of Malacca, which serves as the shortest maritime link between Europe, the Middle East, and Northeast Asia (Zulkifli et al., 2020).

1.2 Problem Statement

The Port of Singapore, Southeast Asia's busiest container port, handled 39.01 million TEUs in 2023, an increase of 1.72 million TEUs over the previous year (Port of Singapore, 2023). Around 80% of its container traffic is transshipment cargo (Nguyen et al., 2020). To enhance operational efficiency, Singapore introduced the Just in Time (JIT) Arrival platform in January 2024 (Singapore Ports Marine Circular No. 10, 2023). While this strategy minimizes fuel use and dwell time, it also indirectly

impacts Malaysian ports due to regional traffic interdependency. For example, Klang West Port faces an average vessel delay of 9.3 hours, and Klang North Port experiences a 1.9-hour delay (Santani & Kamaruddin, 2024). This raises concerns about increasing port congestion and decreased competitiveness in Malaysia.

1.3 Underlying Theory

This study adopts Contingency Theory as the theoretical foundation. The theory proposes that there is no universal management solution; instead, ports must adapt their operations according to dynamic internal and external factors, such as market conditions and environmental shifts (Shala et al., 2021). In this context, Malaysia's ports must respond flexibly to Singapore's evolving port strategies, especially JIT implementation.

1.4 Research Questions

This study aims to explore the influence of Singapore's adoption of Just-In-Time (JIT) platforms on the operational dynamics of Malaysian seaports. In order to guide the research and provide clarity on its scope and direction, the following research questions have been formulated:

1. How does the JIT approach implemented by the Port of Singapore impact operational efficiency at Malaysian seaports?
2. What are the key operational changes observed in Malaysian seaports in response to Singapore's JIT practices?
3. What strategies can Malaysian seaports adopt to enhance operational efficiency and remain competitive under the influence of the JIT approach?

These questions form the basis of the study's investigation into regional port competitiveness, operational adaptation, and strategic decision-making in the context of maritime logistics.

2. METHODOLOGY

This study adopts a qualitative case study design to explore the impact of container vessel congestion at the Port of Singapore on Malaysian ports, specifically Port Klang and Port of Tanjung Pelepas. A purposive sampling technique is used to select port operation staff for semi-structured interviews, ensuring a diverse representation of roles. Data collection involved conducting interviews with three respondents to gain insights into operational challenges and responses. The primary research instrument is semi-structured interviews, allowing flexibility in probing key themes. Thematic analysis will be employed to interpret qualitative data, identify patterns, and address the research objectives comprehensively.

3. ANALYSIS AND RESULT

This chapter presents the findings and discussion of a qualitative study on how Just-in-Time (JIT) practices at the Port of Singapore affect the operational efficiency of Malaysian seaports. Insights were gathered through semi-structured interviews with key port personnel, highlighting operational challenges, changes, and strategic responses to JIT implementation.

3.1 Thematic Analysis

Table 2 Thematic Analysis

First Themes	Initial Themes	Exemplary codes	Informants who imply this theme
Influence of JIT Implement in Singapore	Improvement and decline in operational efficiency	Improvement: • Expansion of Port Capacities • Improved Customs and Clearance Processes • Operational Efficiency and Cost Reduction. Decline: • Congestion and Delays • Automation and Digitalisation • Capacity Expansion	Wan Saiful, Ares, Anuar
Operational changes	Global Trade demand		Wan Saiful, Ares, Anuar
	Technology and Operational Adaption	Technological and operational changes • Terminal Operating System (TOS) for Cargo and Yard Optimisation • OCR for Container Damage Detection and Auto-Tally Challenges in implement technology • Foreign Systems and Expertise • Cyberthreats • Capital Investment	Wan Saiful, Ares, Anuar
	Port Facility and Operational flexibility	Adjustment to enhance facilities and operation flexibility. • Infrastructure Expansion • Contingency Measures for External Disruptions • Equipment and Yard Flexibility	Wan Saiful, Ares, Anuar
Strategies for Malaysia seaport to enhance operational		• Technological Investment • Digitalisation and Smart Port Initiatives • Multimodal Transport and Connectivity Improvement	Wan Saiful, Ares, Anuar

3.2 To examine the extent to which the JIT approach by Port of Singapore influences operational efficiency at Malaysia Seaport.

This section evaluates how Singapore's Just-in-Time (JIT) practices influence Malaysian port operations and the perspectives of local port executives.

3.2.1 Expansion of Port Capacities and Infrastructure Upgrades

Singapore's adoption of JIT has been accompanied by major infrastructure investments, including smart technologies like automated cranes and blockchain systems, which have reduced delays (Maritime and Port Authority of Singapore, 2025). In response, Malaysian ports are upgrading their own facilities to stay competitive. Interview responses revealed that ports like Penang have diversified services through terminals like NBCT and BWCT to enhance throughput (Ming et al., 2020).

3.2.2 Improved Customs and Clearance Processes

Singapore's integration of NCC Cargo and digital solutions into its JIT system has streamlined clearance and improved security (Immigration and Checkpoints Authority, 2022). Influenced by this, Malaysia has implemented uCustoms and the National Single Window to simplify documentation and reduce cargo dwell time from 4 to 2 days (Royal Malaysian Customs Department, 2025).

3.2.3 Operational Efficiency and Cost Reduction

JIT at the Port of Singapore has improved cargo flow, reduced vessel dwell times, and lowered costs. Malaysian respondents observed that JIT helps avoid demurrage charges, promoting punctuality among vessels heading to both countries (Katrien et al., 2023). However, limitations in infrastructure and automation continue to restrict cost savings in Malaysian ports.

3.2.4 Congestion and Delays

Despite the benefits, JIT has also contributed to congestion in Malaysian ports, as vessels struggle to align with Singapore's strict schedules. Respondent 3 noted that limited automation in Malaysia has led to missed loading deadlines and cargo delays, affecting customer satisfaction and port reputation.

3.3 Operational Changes in Malaysian Seaports in Response to Singapore's JIT Practices

Malaysian seaports have undergone significant changes in response to Singapore's adoption of Just-in-Time (JIT) practices. These developments are broadly categorized into three themes: global trade demand, port facilities, and technological and operational adaptation.

3.3.1 Global Trade Demand

The increasing pressure from global trade and Singapore's JIT system has driven Malaysian ports to upgrade infrastructure and improve efficiency.

3.3.1.1 Infrastructure Upgrades

Malaysia has invested in automation and digitization technologies to boost port productivity. Innovations such as automated cranes, AGVs, and digital management systems help reduce errors and provide real-time cargo data. Respondent 1 highlighted Port Klang and Port of Tanjung Pelepas's adoption of the Navis N4 Terminal Operating System (TOS), with Port Klang partnering with Kaleris since January 2024 (MMC Ports, 2024). Port of Tanjung Pelepas also implemented smart gates to minimize human error and congestion. Respondent 2 noted that Penang Port is developing an AI system focusing on berth, yard, and marine management, expected to launch in July 2025. Meanwhile, PELKON is currently in use, providing electronic data interchange and gate automation (Samah et al., 2021).

3.3.1.2 Capacity Expansion

To meet future demand, ports are expanding capacity and accommodating larger vessels. Westport Klang's Terminal 2 Expansion Project, supported by the Malaysian government, aims to increase

capacity from 14 to 28 million TEUs by adding terminals and deepening the draft (Mandra, 2024). Respondent 1 stated that Penang Port also seeks expansion, as 2024 cargo throughput rose to 32.33 million weight tons with a 31.18% increase in vessel calls (Malay Mail, 2025). However, Penang Port faces spatial and reclamation challenges, limiting its expansion pace compared to Port Klang and PTP.

3.3.2 Technological and Operational Adaptation

Inspired by Singapore's advanced digital Tuas Port, Malaysia is modernizing through automation and digital tools. Despite progress, challenges such as reliance on foreign systems, cybersecurity risks, and capital costs remain.

3.3.2.1 Terminal Operating System (TOS)

TOS platforms streamline cargo handling, gate functions, and enable EDI, offering real-time data and cloud-based flexibility (Gekara et al., 2020). All major Malaysian ports have adopted TOS systems—Port Klang and PTP with Navis N4, and Penang Port expected to begin implementation by July 2025. Respondent 1 noted that NBCT integrates smart gates with TOS, enabling better coordination, route planning, and reduced bottlenecks.

3.3.2.2 OCR for Container Detection

Penang Port employs OCR for damage detection and cargo tallying, integrating with TOS for real-time container flow data (Zhang et al., 2024). The unmanned gate system, combined with OCR, enables faster, more secure cargo handling.

3.3.2.3 Implementation Challenges

Challenges include reliance on foreign expertise, as systems like Navis N4 and Penang's upcoming TOS originate from the U.S. and South Korea respectively. This limits local capacity for maintenance and upgrades. Cybersecurity is another concern; IoT vulnerabilities pose threats as seen in the Port of San Diego cyberattack (The Maritime Executive, 2018). Respondent 1 and 3 added that high investment costs necessitate government support for smart port development.

3.3.3 Port Facility and Operational Flexibility

To maintain smooth logistics, Malaysian ports focus on equipment upgrades and flexible operations.

3.3.3.1 Infrastructure Expansion

PTP invested RM750 million in 2022 to raise capacity from 11.5 to 12.5 million TEUs, including new cranes and a berth to support Sumatra-linked cargo flows (Pelabuhan Tanjung Pelepas Sdn Bhd., 2022).

3.3.3.2 Contingency Measures

Respondent 1 stated that Malaysian ports have established and regularly update contingency plans for disruptions, ensuring consistent operations amidst issues like the Russia-Ukraine war and Red Sea crisis.

3.3.3.3 Equipment and Yard Flexibility

Respondent 2 explained that Penang Terminal's berth and crane allocations vary by vessel size and terminal congestion. T2 handles large ships with Super Panamax cranes at 30–34 moves/hour, while T1 serves smaller vessels with fewer resources, ensuring operational flexibility and efficiency.

3.4 Strategies for Enhancing Operational Efficiency at Malaysian Seaports in Response to JIT Approach

In response to Singapore's competitive Just-In-Time (JIT) approach, Malaysian seaports are adopting several strategies to boost operational efficiency and remain competitive.

3.4.1 Technological Investment

Respondent 1 highlighted that Penang Port currently uses 10 Rail Mounted Gantry Cranes (RMGs), which are more costly and slower than Rubber Tyred Gantry Cranes (RTGs) due to their diesel-fueled operation (DGCRANE, 2025). Although RMGs are automated, full automation at Penang Terminal remains unachievable without upgrading other supporting systems. Therefore, he emphasized the need for increased investment in automated crane systems to secure Malaysia's standing in international port rankings.

3.4.2 Digitalisation and Smart Port Initiatives

Beyond hardware upgrades, Malaysian ports are focusing on digitalisation and smart port technologies. Respondent 3 mentioned that Port Klang is advancing its Smart Port Initiative (SPI), which integrates AI, IoT, and blockchain to enhance cargo tracking, customs processes, and ship call scheduling. Additionally, Tanjong Pelepas Port has adopted an Artificial Intelligence Terminal Management System, leveraging predictive analytics to improve container transport efficiency by 77% (Pelabuhan Tanjung Pelepas Sdn Bhd., 2022).

3.4.3 Multimodal Transport and Connectivity Improvement

Respondent 3 also noted Malaysia's strategic location enables enhancements in intermodal transport. Unlike Singapore's focus on transhipment, Malaysia is expanding its rail and road networks to offer diversified services. Ports such as Tanjung Pelepas, Port Klang, and Penang are connected by rail, including the Padang Besar Rail Link to Thailand and China. Respondent 2 added that over 80% of Penang Terminal's trade is with Far East Asia, especially China, making improved connectivity a vital strategy for attracting more East Asian customers.

4. DISCUSSION

This study highlights the impact of Singapore's Just-in-Time (JIT) model on Malaysian ports, showing that while Malaysia has made significant strides in improving port infrastructure and operations, gaps remain in the automation and digitisation of port systems. The findings support past studies, such as those by Dahlman (2007), which suggest that excessive reliance on foreign-developed technologies can increase costs and hinder local development. For example, Malaysia's Penang Port lags behind Singapore's Tuas Port in terms of automation and technology integration.

However, this study has some limitations, particularly the small sample size due to challenges in obtaining responses from Malaysian port executives. This restricted the diversity of views and may have resulted in missed operational insights. Expanding the sample size and incorporating data from other stakeholders, such as shipping companies and government agencies, would provide a more comprehensive understanding.

Future research should explore developing locally customised digital solutions to reduce dependency on foreign technology. Additionally, a broader sampling strategy, incorporating big data and government reports, could provide deeper insights into the challenges and opportunities facing Malaysian ports in the evolving global trade landscape.

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Examining The Relationship Between Perceived Ease of Use (PEOU), Perceived Usefulness (PU), and Trust on Automation Adoption Intentions in Penang's Warehousing Industry

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ABSTRACT

The study examines factors influencing warehouse automation adoption intentions among workers in Penang, focusing on Perceived Ease of Use (PEOU), Perceived Usefulness (PU), and Trust, using the Technology Acceptance Model (TAM). Despite global growth in warehouse automation, Penang's adoption remains low due to concerns over complexity, cost, and reliability. A quantitative survey of 120 warehouse employees revealed that Trust ($\beta = 0.497$, $p < 0.01$) significantly predicts adoption intention, while PEOU and PU were excluded due to low reliability and cross-loading issues. The findings discovered that trust is the most important factor influencing warehouse workers' acceptance of automation, indicating that businesses should prioritize building trust in the system rather than solely highlighting its ease and helpfulness. Practical recommendations include transparency initiatives, hybrid workflows, and third-party certifications to boost confidence, and regulatory frameworks for automation ethics. However, the study's regional focus and limited managerial perspectives suggest future research should expand across Malaysia's logistics hubs and diverse operational scales.

Keywords: Warehouse Automation; Adoption Intention; Perceived Ease of Use (PEOU); Perceived Usefulness (PU); Trust

1. INTRODUCTION

Warehouses are pivotal in global supply chains, enabling efficient storage, order processing, and distribution (Kembro and Norrman, 2022). The rise of e-commerce has intensified demand for automation technologies like Automated Guided Vehicles (AGVs) and Warehouse Management Systems (WMS) (Nilsson and Jayaraman, 2021). While the global warehouse automation market is projected to grow from $23 billion in 2023 to $41 billion by 2027 (Placek, 2023), adoption in Penang remains low.

Despite automation's potential for enhancing efficiency and reducing labor costs, Penang's warehousing industry faces resistance due to concerns over complexity, cost-effectiveness, and system reliability (Penang Institute, 2023). Employees perceive automation as difficult to use, question its long-term benefits, initial costs associated with automation, and distrust its safety and data security (Hao et al., 2020; Varghese and Saju, 2021; Golgeci et al., 2025). These barriers hinder adoption, limiting the sector's competitiveness. This study aims to investigate how PEOU, PU, and Trust influence automation adoption intentions, addressing gaps in understanding industrial technology acceptance.

The study is grounded in the Technology Acceptance Model (TAM), which posits that technology adoption is driven by PEOU and PU (Davis and Granić, 2024), with the addition of trust as a third factor to provide a more complete understanding of why warehouse workers accept or reject automation.

The objective of this study is to examine the relationship between PEOU, PU, and trust in relation to automation adoption intention within the warehousing industry. Previous literatures have validated the influence of PEOU, PU and trust on adoption intention (Ajina et al., 2024; Mahomed et al., 2023; Wahab et al., 2022). On this ground, three hypotheses were formulated: (H^1) PEOU positively influences automation adoption intention, (H^2) PU positively influences automation adoption intention, and (H^3) trust positively influences automation adoption intention.

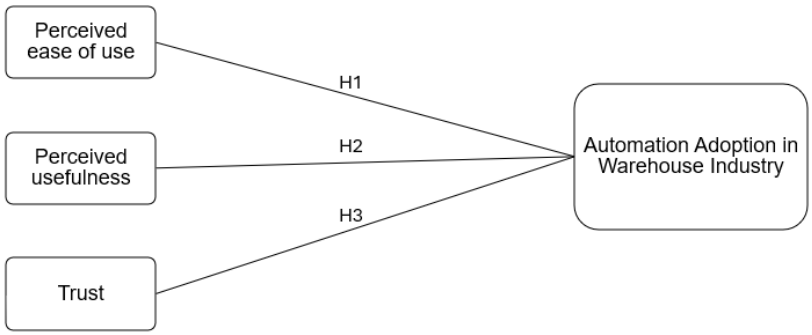

Figure 1 Conceptual Model

2. METHODOLOGY

This study employed a cross-sectional quantitative research design (Adedoyin, 2020) to examine the relationship between PEOU, PU, Trust, and automation adoption intentions. A non-probability convenience sampling method was used due to limited time and resources (Kim, 2022). Participants were recruited based on the researcher's accessibility (Ahmed, 2024), with inclusion criteria requiring at least one year of working experience in a warehouse setting and a minimum age of 18. These criteria were established to ensure the relevancy of the subject matter and the quality of the data collected.

Data was collected via an online structured questionnaire distributed over four weeks through email, WhatsApp, and Telegram. The survey was hosted on Microsoft Forms, ensuring anonymity and voluntary participation. Screening questions verified respondents' eligibility (warehouse employment in Penang). Two reminder prompts were sent to improve response rates. Ethical protocols included informed consent and confidentiality assurances, with raw data securely stored for analysis.

The measurement of construct adopts adoption intention, PEOU, PU, and trust from Shankar and Datta (2018) and uses a 5-point Likert scale to assess levels of agreement (Rothermich et al., 2019). A pilot test was also conducted to ensure clarity and comprehensibility of the items. This paper uses IBM's Statistical Package for the Social Sciences (SPSS) version 28.0.1.1 to conduct statistical analysis.

3. ANALYSIS AND RESULTS

The study surveyed 120 (n=120) warehouse employees in Penang, with a balanced gender distribution (54.2% female, 45.8% male) and a predominantly young workforce (49.2% aged 21-30). Most respondents held diploma-level education (40%) and worked as operators (46.7%) or material handlers (37.5%), reflecting frontline perspectives on automation adoption.

The ensure scale validity, a factor analysis was performed. Based on the result, several items were removed due to cross-loading issues, specifically PEOU1, PEOU2, PEOU3, TRUST1, TRUST2, TRUST5, PU1, and PU4. Subsequently, a reliability analysis was conducted. The result indicated that adoption intention and trust exhibited moderate reliability (α= 0.522 - 0.617). Further decisions were made to remove PU due to its low reliability. Hence, only H3 will proceed for further analysis, following the removal of PEOU (H1) and PU (H2) due to validity and reliability concerns.

Table 1 Summary of Hypothesis Testing Results

Hypotthesis	Relationship	Beta	Std Error	t value	R2	Decision
H3	Adoption Intention à Trust	0.497	0.57	6.217**	0.52095	Supported

$p < 0.01$**

In the hypothesis testing, the result confirmed that trust demonstrated that Trust significantly predicts Adoption Intention ($\beta = 0.497$, $p < 0.01$), explaining 52.1% of the variance ($R^2 = 0.52$). The finding suggests that higher levels of trust in warehouse automation are associated with greater intentions to adopt automation technologies, indicating the critical role of trust in adoption decisions.

4. DISCUSSION

The findings challenge conventional Technology Acceptance Model (TAM) assumptions by demonstrating that trust significantly outweighs perceived ease of use and usefulness in driving automation adoption intentions among warehouse workers. This aligns with prior industrial technology studies (Wahab et al., 2022) where system reliability and ethical concerns proved more influential than usability factors.

Theoretically, this study extends TAM by identifying trust as a dominant factor in industrial automation contexts, suggesting model adaptations for logistics settings. Practically, results emphasise the need for transparency initiatives (e.g., real-time performance dashboards), hybrid human-machine workflows to ease transitions, and third-party certifications (e.g., SIRIM) to validate system safety. These highlight the importance of regulatory frameworks to standardise automation ethics and worker protections.

The study was constrained by its exclusive focus on Penang, limiting generalisability to other regions with differing labour or technological infrastructures. The underrepresentation of other logistics operations (such as transportation or last-mile delivery) or to account for respondents' differing perspectives on PEOU, PU, and trust in automation. Additionally, the study failed to consider that automation adoption patterns can vary by firm size or by industry needs (e.g., pharmaceutical or electronics warehouses).

Future studies should expand geographically to compare adoption drivers across Malaysia's logistics hubs (e.g., Selangor, Johor). Furthermore, broadening to incorporate more respondents from other critical logistics operations like transportation (e.g. transportation and last-mile delivery services), companies of varying sizes, on how organizational scale influences automation decisions, along with examining facilities at different automation stages from manual to advanced smart warehouses.

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A Study of The Relationship Between Green Supply Chain Management Practices and Environmental Performance Among Freight Forwarders n Malaysia

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ABSTRACT

The growing focus on sustainability has pushed the logistics industry to implement green supply chain management (GSCM) strategies to improve environmental performance (EP). This study investigates the relationship between Green Logistics (GL), Green Purchasing (GP), Green Innovation (GI), and Reverse Logistics (RL) practices and their impact on Environmental Performance (EP) in Malaysia's freight forwarding industry. Data were collected from 232 Malaysian freight forwarding companies' employees in Selangor and Penang through an online survey. The findings reveal a positive and significant relationship between GL, GP, and RL practices to EP, indicating that organisations adopting these practices experience lower greenhouse gas emissions, improved resource efficiency, and enhanced corporate sustainability. This study contributes to the understanding of how GSCM practices can enhance the environmental performance of Malaysia's freight forwarding industry. A few practical recommendations for fostering sustainability in freight forwarding companies were also outlined.

Keywords: Green Supply Chain Management; Environmental Performance; Green Logistics; Green Purchasing; Reverse Logistics

1. INTRODUCTION

The logistics and freight forwarding industry is a key enabler of international trade, supporting the efficient and reliable movement of goods across borders. In Malaysia, this sector has expanded rapidly, driven by globalisation, e-commerce growth, and the increasing demand for just-in-time delivery services. With a contribution of 3.8% to the nation's GDP and employing over 667,000 people (OECD, 2021), freight forwarding plays a vital economic role. However, this growth has raised significant concerns about environmental sustainability, as freight activities, including transportation and warehousing, are major contributors to carbon emissions, energy consumption, and environmental degradation. Freight transport alone accounts for about 28% of Malaysia's CO_2 emissions (Mustapa and Bekhet, 2016). Heavy reliance on fossil fuels and inefficient reverse logistics practices further exacerbate air pollution, climate change, and health risks (Saravanan and Kumar, 2016; Ankathi et al., 2022; Osman et al., 2023). Regulatory pressures and societal expectations for greener operations are increasing (Liu et al., 2022), but many freight forwarders remain focused on operational priorities, neglecting environmental initiatives (Vachon and Hajmohammad, 2016; Kathiarayan and Sundarapandiyan, 2023). Given Malaysia's growing trade volumes (Matrade, 2024) and the environmental risks associated with poor logistics management, this study aims to explore how GSCM practices can enhance environmental performance and promote sustainable growth in the freight forwarding industry.

According to the Resource-based view (RBV), the green practices in the organisations can be treated as unique organisational capabilities that will enhance the organisation's competitiveness and performance (Choi, Min and Joo, 2018). Previous research shows that green logistics practices (GL) are positively connected with EP (Sidek *et al*., 2021; Mohsin *et al*., 2022). Greening inbound logistics includes optimising transportation processes to reduce the shipment of bulk items, prioritising the procurement of sustainable and eco-friendly resources, and adopting practices to reduce, recycle, and reuse materials (Dey, LaGuardia, and Srinivasan, 2011; Jayarathna, Agdas, and Dawes, 2023). Such initiatives enable companies to lower their overall effect on the environment substantially (Afum *et al*., 2022). Hence,

H1: There is a positive relationship between green logistics and environmental performance.

Various empirical studies have studied the relationship between green innovation (GI) and environmental performance, demonstrating that GI can substantially enhance it. By implementing green processes and product innovations, companies can fundamentally alter their operational methods for existing products and processes, potentially leading to the creation of new products and processes that greatly reduce negative environmental impacts, thereby enhancing overall EP (Qiu *et al*., 2020; Rehman *et al*., 2021; Mittal and Kaur, 2023). Therefore, we hypothesise:

H2: There is a positive relationship between green innovation and environmental performance.

Researchers have recognised the importance of involving purchasers and suppliers in the enhancement of environmental performance (Shaharudin *et al*., 2018). Several studies have validated the significant relationship between green purchasing (GP) and EP (Chin *et al*., 2020). According to Najmi *et al*. (2020), they proposed that greening suppliers positively influence green purchasing skills subsequently positively affect EP, financial performance, and competitive advantage. In addition, the organisations that implement green practices in their procurement processes can gain benefits such as cost savings, improved public image, and reduced liability. Henceforth,

H3: There is a positive relationship between green purchasing and environmental performance.

The implementation of reverse logistics (RL) significantly impacts the EP of organisations (Kaihan and Chin, 2021; Le, 2023). RL actions, through resource recycling, product reuse, and remanufacturing, mitigate disposal and hazardous materials in the environment, reduce pollution, preserve resources, and positively influence the environment and global warming by returning items and reducing their carbon footprint, which improves firms' environmental protection image (Hashemi, 2021; Wilson and Goffnett, 2022).

H4: There is a positive relationship between reverse logistics and environmental performance.

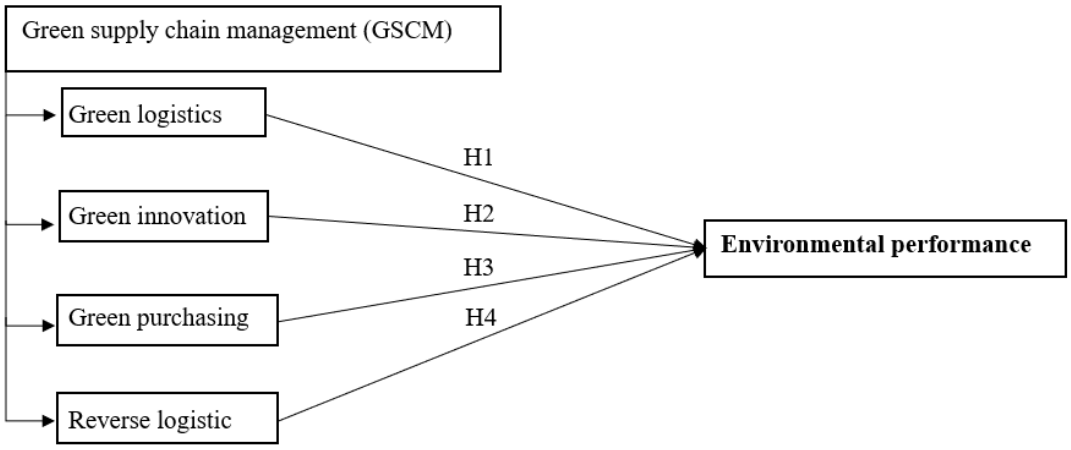

Figure 1 Conceptual Framework

2. METHODOLOGY

This study adopts a cross-sectional, quantitative survey approach, using a structured questionnaire as the primary research tool. A non-probability purposive sampling technique was adopted in this research to target individuals with specific knowledge and experience in logistics, ensuring the relevance and accuracy of the data collected. The survey is distributed through Google Forms via email. An email listing is obtained from the Selangor Freight Forwarder and Logistic Association (SSFLA) that consists of 790 companies. Additionally, the survey link is also shared via social media platforms such as WhatsApp, using contact numbers available on the SSFLA website, to accelerate the data collection process. All the data is collected within a month. While distribution is primarily online, printed copies are also provided to companies preferring physical formats, particularly those with limited internet access.

The questionnaire will gather basic demographic information about the respondents, such as age, gender, job role, years of experience, and type of company. For the measurement of construct, we adopted EP from Green *et al*. (2012), GL from Baah, Jin and Tang, (2019), GI from Lin and Ho, (2008), GP from Zhu, Sarkis, and Lai, (2008), and RL from Eltayeb and Zailani, (2009). A 5-point Likert scale (1-strongly disagree to 5-strongly agree) was used to measure participants' levels of opinion regarding EP and GSCM practices. The data collected will be processed for statistical analysis by using the Statistical Package for the Social Sciences (SPSS).

3. ANALYSIS AND RESULTS

A total of 232 responses were collected, with 20 invalid responses removed due to criteria mismatch, leaving a final usable sample of n=212. We proceed with factor loading to ensure the validity of the measures. Based on the results, items GP5, GL1, GL3, RL2, RL3, RL4, RL6, and all items under GI were removed due to issues with cross-loadings and low factor loadings, falling below the acceptable threshold of 0.7. The Kaiser-Meyer-Olkin (KMO) measure and Bartlett's Test of Sphericity indicate adequate sampling and statistical significance, confirming the suitability of the data. The decision to remove H2 was made due to the low validity and poor construct reliability. Thereafter, we proceed with a reliability test confirming all remaining variables show a good reliability coefficient ranging from α=.630 to α=.932. The Pearson correlation analysis also indicates that there are strong and significant correlations between all the variables.

Table 1 Hypothesis Testing Result

Hypothesis	Relationship	Beta	Std Error	*t* value	R^2	Decision
H1	GP → EP	0.407	0.039	11.218**	0.888	Supported
H3	GL → EP	0.523	0.042	11.345**	0.888	Supported
H4	RL → EP	0.098	0.033	2.847**	0.888	Supported

$p < 0.05$*, $p < 0.01$**

Note. GP, Green purchasing; GL, Green logistics, RL, Reverse logistics, and EP, Environmental Performance.

Based on the hypothesis testing, all hypotheses are accepted with R^2= .888, indicating that 88.8% of the variance in EP is explained by the independent variables. H1 shows there is a significant relationship between GP and EP (β = 0.407, t = 11.218, p < 0.01). For H3, the relationship between GL and EP is positive and significant (β = 0.523, t = 11.345, p < 0.01). Lastly for H4, the relationship between RL and EP is also positive and significant (β = 0.098, t = 2.847, p < 0.01).

4. DISCUSSION

The results of this study demonstrate that GP, GL, and RL all have significant and positive effects on EP among freight forwarders in Malaysia. These findings are strongly aligned with prior research. Specifically, the positive impact of GP supports the conclusions of Najmi et al. (2020) and Al-Ghwayeen and Abdallah (2018), who emphasized the role of sustainable procurement and supplier collaboration in enhancing environmental outcomes. Similarly, the significant influence of GL on EP is consistent with studies by Sidek et al. (2021) and Afum et al. (2022), which highlighted how energy-efficient transportation and waste reduction improve sustainability performance. Furthermore, the relationship between RL and EP affirms earlier findings by Hashemi (2021) and Wilson and Goffnett (2022), which noted that practices like product recycling and reuse not only reduce environmental harm but also promote resource efficiency.

From a theoretical perspective, this study extends the application of RBV into the context of freight forwarding in Malaysia, a sector that has been less explored compared to manufacturing industries in previous studies. The findings support the idea that internal resources, specifically sustainability-related practices, are critical drivers of performance rather than external environmental factors alone. For managerial implications, this study provides important insights for managers and decision-makers in the freight forwarding industry. It identifies which GSCM practices such as green logistics, green purchasing, green innovation, and reverse logistics are most effective in enhancing environmental outcomes. This guidance can help companies prioritise resource allocation, design more strategic sustainability initiatives, and improve compliance with growing environmental regulations.

Several limitations should be acknowledged. Firstly, the limited sample size, that primarily from Selangor and Penang, may affect the generalisability of the findings across Malaysia. Secondly, the reliance on closed-ended survey questions restricted the depth of insights into respondents' true perceptions and experiences with GSCM practices. Lastly, the use of quantitative methods constrained the ability to explore organisational and cultural dynamics that could significantly influence the adoption and effectiveness of green logistics, reverse logistics, and green purchasing initiatives.

Future research should focus on overcoming these limitations to further strengthen the understanding of GSCM practices and EP in Malaysia's freight forwarding sector. First, a larger sample size of at least 500 to 600 respondents is desired to enhance statistical reliability and reduce the margin of error. Second, expanding the regional scope beyond Selangor and Penang to improve the generalisability of findings and capture regional differences in GSCM implementation. Third, future researchers are encouraged to incorporate open-ended questions into the survey instrument to allow respondents to elaborate on the barriers, opportunities, and experiences related to GSCM practices. Finally, applying qualitative research methods, such as case studies and thematic analysis, could explore in greater depth why certain practices, such as green innovation, show insignificant relationships with EP.

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The Relationship between Change Readiness and AWS Adoption in Warehouses

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ABSTRACT

This study investigates warehouse employees' readiness to adopt Automated Warehouse Systems (AWS) in the context of Malaysia's slow transition towards smart warehousing. Guided by the ADKAR and UTAUT models, the research focuses on five key factors: awareness, desire, knowledge, ability, and reinforcement. A quantitative method was employed, surveying 102 warehouse workers using validated instruments. Data were analysed through SPSS using factor, reliability, correlation, and regression analyses. The results showed that awareness and reinforcement significantly influenced change readiness, while desire, knowledge, and ability were not strong predictors. The findings highlight the importance of clear communication and continuous support in preparing employees for automation. This study fills a gap in UTAUT-based warehouse research and offers practical insights for HR and operations leaders to enhance training, engagement, and change strategies.

Keywords: Automated Warehouse Systems; Change Readiness; ADKAR Model; UTAUT; Employee Adoption

1. INTRODUCTION

The rapid advancement of Industry 4.0 technologies has transformed global supply chains, pushing companies to modernise warehouse operations to stay competitive. Leading organisations like Amazon and Alibaba have embraced automated warehouse systems (AWS) to boost efficiency, accuracy, and responsiveness (Kembro & Norrman, 2022). Smart warehouses rely on technologies such as RFID, robotics, and real-time analytics to manage complex logistics tasks (van Geest et al., 2022). However, Malaysia's AWS implementation remains limited, with many warehouses still operating manually (Ooi et al., 2023).

Technology alone does not guarantee success employee readiness is key. This study responds to Malaysia's lag in automation by examining factors that influence warehouse employees' willingness to adopt AWS. While the Unified Theory of Acceptance and Use of Technology (UTAUT) has been widely applied to study technology adoption, its use in the context of warehouse automation remains underexplored. UTAUT proposes that behavioural intention to use technology is influenced by factors such as performance expectancy, effort expectancy, social influence, and facilitating conditions (Venkatesh et al., 2003; Marikyan & Papagiannidis, 2021). Yet, recent research suggests that other elements such as awareness, desire, knowledge, ability, and reinforcement may play critical roles in preparing employees for organisational change, particularly in high-impact and technology-driven environments like warehouses, where successful transformation depends heavily on individual readiness and adaptability .To address this gap, the study sets out to:

1. To examine the relationship between awareness of the need for change and change readiness.
2. To examine the effect of desire to support change on change readiness.

3. To examine the impact of knowledge about how to change on change readiness.
4. To examine the influence of ability to implement change on change readiness.
5. To examine the effect of reinforcement mechanisms on change readiness.

By identifying these key factors, the study not only contributes to UTAUT-based research in logistics but also offers practical strategies for HR and operations leaders. These findings can improve training, communication, and support mechanisms, ensuring smoother transitions, higher adoption rates, and safer, more efficient warehouse environments.

Research Framework

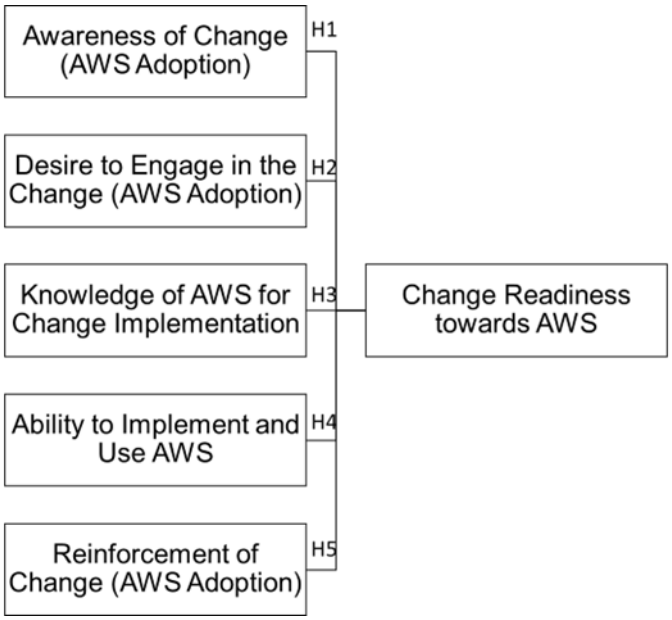

Figure 1 Research Framework

This section analyses the proposed conceptual framework, which aims to explain how five key factors influence employees' readiness to adopt Automated Warehouse Systems (AWS). Awareness of change is a crucial first step in preparing employees for AWS adoption, as it involves understanding why the change is necessary, such as improving productivity, efficiency, and profitability (Change Strategists, 2023). The ADKAR model emphasises that awareness helps reduce resistance by clarifying the purpose behind the change (Marsicano, 2021), while clear leadership communication plays a key role in aligning employee attitudes (Kotter, 1996). Once aware, employees must develop the desire to support the change. This refers to their motivation to actively engage in AWS adoption, which is strengthened when they see benefits like enhanced job satisfaction and operational performance (Albrecht et al., 2020). Leadership support, optimism, and peer influence further reinforce this desire (Bah et al., 2024; Lawson & Price, 2003). However, awareness and desire alone are insufficient without the necessary knowledge of how to implement AWS effectively. Employees need to understand how AI-based systems function to make informed decisions, reduce errors, and adapt efficiently (Lototsky et al., 2018; Cassettari et al., 2021; Panzer & Gronau, 2023). This knowledge must be supported by the ability to use the system, which includes technical skills and confidence developed through structured training, support systems, and accessible resources (Mudjisusatyo et al., 2024; Chen et al., 2020; Laine, 2024). Finally, sustained adoption relies on reinforcement, where continuous feedback, recognition, and reinforcement learning systems ensure

long-term engagement and performance optimisation (Sodiya et al., 2024; Padakandla, 2021; Leon et al., 2023). The framework is guided by the ADKAR model and UTAUT, focusing on awareness, desire, knowledge, ability, and reinforcement as independent variables. Based on this, the following hypotheses are proposed:

H_1: There is a positive relationship between awareness of change and change readiness towards AWS.
H_2: Employees' desire to engage in the change positively impacts change readiness towards AWS.
H_3: Knowledge of AWS for change implementation is positively associated with change readiness.
H_4: The ability to implement and use AWS significantly enhances change readiness towards AWS.
H_5: Reinforcement of change (e.g., incentives, feedback) positively affects readiness towards AWS adoption.

2. METHODOLOGY

This chapter presents the methodology used to examine warehouse workers' readiness to adopt Automated Warehouse Systems (AWS). Guided by a positivist philosophy, the study uses a quantitative approach and structured surveys to gather measurable data. This study adopts a non-probabilistic stratified sampling technique to ensure equal representation of warehouse employees involved in operations such as inventory control, order picking, and equipment handling. Using G-Power analysis, the minimum sample size required was determined to be 92 respondents, based on a medium effect size (0.15), a significance level of 0.05, and statistical power of 0.80 with five predictors. Data were collected via an online survey using Google Forms over a three-week period, following a pre-test to ensure clarity and reliability of the instrument. The structured questionnaire, adapted from validated sources, includes seven sections: demographic details and constructs measuring change readiness, awareness, desire, knowledge, ability, and reinforcement related to AWS adoption. Each construct comprises four items, using measurement scales sourced primarily from Kachian, Elyasi and Haghani (2018), and others including Rafferty and Minbashian (2019) and Junaedi (2018). The collected data were securely stored, anonymised, and analysed using SPSS software. Instruments were adapted from validated sources to measure key variables, including awareness, desire, knowledge, ability, and reinforcement. Data will be analysed using SPSS through descriptive, factor, reliability, correlation, and regression analyses to identify key predictors of change readiness and support automation strategies in warehouse environments.

3. ANALYSIS AND RESULTS

This chapter presents the results of data analysis examining warehouse employees' readiness to adopt Automated Warehouse Systems (AWS). The demographic profile of 102 respondents showed a balanced gender distribution (51% male, 49% female). Most respondents were aged between 26–35 years (37.3%), followed by 36–45 (24.5%) and 18–25 (22.5%), indicating a young and active workforce. In terms of education, 52.9% held a bachelor's degree, while others had diplomas, master's degrees, or professional qualifications. A large portion (31.4%) had 11–20 years of work experience, reflecting strong industry exposure.

Factor and reliability analyses confirmed the validity of the measurement model, with all Cronbach's Alpha values exceeding 0.8, indicating good internal consistency. Correlation analysis showed all five independent variables—awareness, desire, knowledge, ability, and reinforcement—were positively associated with change readiness. However, regression results revealed that only awareness of change ($\beta = 0.363$, $p < .001$) and reinforcement ($\beta = 0.254$, $p = .022$) had significant predictive power.

These findings highlight the importance of communicating the need for change and providing ongoing support to ensure employee readiness for automation. Meanwhile, motivation, knowledge, and ability, while relevant, were not sufficient on their own to drive meaningful readiness for AWS adoption.

4. DISCUSSION

This study examined the relationship between change readiness and warehouse employees, using a quantitative approach grounded in the ADKAR and UTAUT models. The findings revealed that awareness and reinforcement significantly influence change readiness, while desire, knowledge, and ability were less impactful. These insights align with prior research emphasising the importance of communication and support in driving successful technological change (Hiatt, 2006; Venkatesh et al., 2003).

However, despite these findings, Malaysia continues to lag behind regional leaders like Thailand in advancing Warehouse 4.0 initiatives, highlighting a gap between readiness and actual implementation (Boonsothonsatit et al., 2020). This implementation gap may be attributed not only to employee factors but also to broader systemic and operational challenges. Notably, current academic research offers limited exploration into the technical, human, and managerial complexities involved in designing and operating such systems (Azadeh et al., 2024).

To bridge this gap, future studies should consider adopting mixed methods approaches that combine both qualitative and quantitative data. Such integration would allow researchers to capture the measurable dimensions of change readiness while also exploring contextual nuances—particularly important in logistics and supply chain environments where employee perceptions, system complexity, and operational performance are deeply interconnected (Grant et al., 2023).

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Social Sustainability Practices Within The Logistics Industry in Penang.

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ABSTRACT

This study explores how workplace safety, fair wages, company policies, and workplace diversity affect social sustainability in logistics companies in Penang, Malaysia. Using stakeholder theory and a quantitative approach, data were collected from 90 employees through online surveys. The analysis was conducted using SPSS, covering descriptive statistics, factor analysis, reliability testing, correlation, and regression analysis. The findings show that workplace safety has a significant and positive effect on social sustainability. Meanwhile, fair wages, company policies, and workplace diversity showed positive but not significant impacts. Most respondents were in their prime working years and held university degrees, suggesting a capable and emerging workforce. This study highlights the need for organisations to prioritise safety practices to enhance employee well-being and social responsibility. It also recommends that future research use a mixed methods approach to provide deeper insights and explore broader organisational contexts to strengthen social sustainability efforts in the logistics sector.

Keywords: Social Sustainability; Workplace Safety; Fair Wages; Logistics Sector; Stakeholder Theory

1. INTRODUCTION

Social sustainability has gained significant importance in recent decades as part of a holistic approach to sustainable development, complementing environmental and economic dimensions (Purvis, Mao and Robinson, 2019). It focuses on ensuring the well-being of individuals, communities, and societies by promoting equity, social inclusion, human rights, and community resilience (Armitage et al., 2012; Eizenberg and Jabareen, 2017). In today's globalised world, businesses are increasingly expected to evaluate their social impact both locally and globally, aligning operations including labour practices, stakeholder engagement, and corporate policies with socially responsible standards (Thorlakson, De Zegher and Lambin, 2018).

In the Malaysian context, challenges such as unsafe work environments, wage inequality, underrepresentation in leadership, and inconsistent corporate practices highlight the need for stronger social sustainability initiatives. These issues not only affect employee welfare but also influence organisational trust, reputation, and long-term success (Mani, Agrawal and Sharma, 2015).

To address these gaps, this study sets out to:
(1) To assess the impact of workplace safety on social sustainability,
(2) To evaluate the role of fair wage structures in promoting social sustainability,
(3) To examine the influence of company policies and practices on sustainability, and
(4) To investigate the effects of workforce diversity on social sustainability.

These objectives are examined through the lens of stakeholder theory, which emphasises that companies should consider the interests of all stakeholders to achieve meaningful and lasting sustainability outcomes.

Research Framework

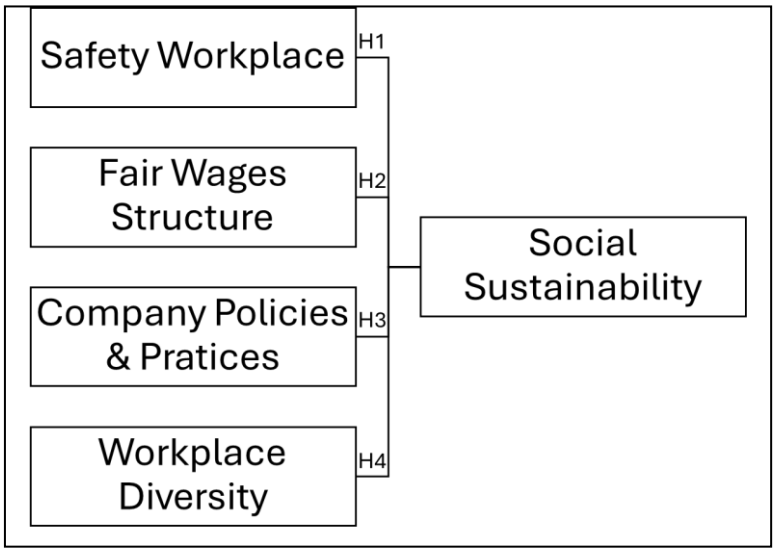

Figure 1 Research Framework

Based on the research objectives and supported by stakeholder theory, this study proposes four hypotheses to examine how internal organisational factors influence social sustainability. These hypotheses focus on the relationship between workplace safety, fair wage structures, company policies and practices, and workplace diversity with social sustainability outcomes. Each hypothesis is grounded in the belief that socially responsible practices not only benefit employees but also contribute to long-term organisational performance and stakeholder satisfaction.

The proposed hypotheses are as follows:

H_1: Workplace safety has a significant positive impact on social sustainability within organisations.

H_2: A fair wage structure positively contributes to social sustainability by enhancing employee well-being and reducing inequality.

H_3: Company policies and practices that prioritise sustainability lead to more socially and environmentally sustainable organisational outcomes.

H_4: Workplace diversity positively influences social sustainability by fostering inclusion, innovation, and equitable opportunities for all employees.

These hypotheses were empirically tested to determine the extent to which each independent variable contributes to social sustainability within logistics and manufacturing organisations.

2. METHODOLOGY

This study follows a positivist philosophy using a quantitative approach to examine how workplace factors influence social sustainability in logistics companies. Data were collected through an online survey using Google Forms, targeting employees from logistics firms in Penang.

A simple random sampling method was used, and G*Power determined that at least 85 responses are needed. The unit of analysis was individual employees. Survey questions cover workplace safety, fair wages, company policies, and workplace diversity, with items adapted from past research.

Data analysis was conducted using SPSS, including descriptive statistics, factor analysis, reliability testing, correlation, and regression analysis.

The study follows strict ethical guidelines, ensuring informed consent, voluntary participation, and data confidentiality throughout the research process.

3. ANALYSIS AND RESULTS

The findings of this study provide meaningful insights into the factors influencing social sustainability within logistics companies. The demographic analysis revealed a diverse respondent profile, with 57.8% male and 42.2% female participants. Most respondents were in the 26–45 age range (58.9%), indicating a workforce in their prime working years. In terms of education, a majority held degrees (43.3%), followed by diploma (16.7%) and master's/PhD holders (14.4%). Additionally, 44.4% had 1–5 years of experience, reflecting a young and emerging workforce.

Regression analysis revealed that among the four independent variables, only workplace safety had a statistically significant and positive effect on social sustainability ($\beta = 0.503$, $p = 0.001$). This highlghts the importance of ensuring employee safety to enhance organisational social responsibility. Other variables such as fair wage structure ($\beta = 0.161$), company policies ($\beta = 0.135$), and workplace diversity ($\beta = 0.026$) showed positive but non-significant relationships with social sustainability.

These results suggest that while workplace safety plays a critical role, fair wages, policy implementation, and diversity may require stronger enforcement or integration with other supportive mechanisms to produce a measurable impact

4. DISCUSSION

This study examined the relationship between workplace factors and social sustainability in logistics companies. While workplace safety emerged as a significant contributor, other factors like fair wage structures, company policies, and diversity showed weaker or non-significant effects. Several limitations were identified, notably the reliance on self-reported data, which may introduce bias due to individual perception and social desirability (Brutus et al., 2013; Perrotta, 2019).

Current literature also lacks regional insights specific to Penang, and often underrepresents employee well-being and long-term CSR outcomes (Hopkins, 2004). Future research should focus on region-specific case studies and the role of digital transformation in logistics sustainability.

A mixed methods approach is recommended to bridge quantitative and qualitative gaps, offering a more complete understanding of workplace practices and stakeholder experiences (Mertens, 2019). This approach would enhance research depth and produce more practical and impactful recommendations for improving social sustainability. Future studies could expand the sample and include moderating or mediating variables to further explore these relationships.

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A Brief Literature Review on The Effect of Age and Workplace-Home Distance on Relationship between Rewards Satisfaction and Employee Turnover

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ABSTRACT

Employee turnover is a major concern in the logistics sector, where operational efficiency and personnel stability are crucial. High turnover rates negatively impacted supply chain performance, increased hiring costs, and reduced productivity, specifically among warehouse workers and truck drivers. Despite bonuses, recognition, and benefits are generally recognised as important variables in employee retention, their effects could differ depending on age and workplace-home distance. The objective of this literature review is to offer insight into how age and workplace-home distance influence the relationship between rewards satisfaction and employee turnover. According to Herzberg's Two Factor Motivation Theory, attractive rewards may increase job satisfaction, but their effect on turnover is influenced by demographic and situational factors. For instance, younger employees may prioritise professional advancement and be more likely to leave their jobs, whereas senior employees might prefer job security and be more open to long-term incentives. Similarly, longer commute times may result in tiredness and decreased job satisfaction, increasing the incentive to leave regardless of reward satisfaction. This analysis emphasises the significance for logistics businesses to consider these moderating elements when developing retention strategies. Employee retention and organisational effectiveness can be improved through a more focused strategy that considers age group and commuter habits.

Keywords: Age; Workplace-Home Distance; Rewards Satisfaction; and Employee Turnover

1. INTRODUCTION

The logistics industry is crucial to global trade because it guarantees that products move smoothly and efficiently across the supply chain. Organisations are recently facing increasing pressure to sustain a consistent and competent employee whereas further improving operational efficiency as the logistics sector is influenced by globalisation and the digital revolution. Nevertheless, employee turnover remains a significant concern. Employee turnover has emerged as a key challenge in the logistics industry, as high employee turnover rates can disrupt supply chain operations, raise operating costs, and lower overall performance (Al-Suraihi et al., 2021). The situation is further complicated by the challenging nature of logistics professions, which require long hours and inconsistent work patterns (Abbott and Gould-Werth, 2020).

Given the circumstances, employee retention has become an essential objective. One of the key elements that drive turnover is rewards satisfaction, which includes both compensation and non-monetary recognition such as appreciation or career development possibilities (Aremo et al., 2024). Aside from that, workplace-home distance is becoming increasingly essential, as long travel distances can contribute to exhaustion, decreased productivity, and lower job satisfaction (Rombaut and Guerry, 2021). Age differences influence turnover trends; younger workers may desire professional advancement and learning opportunities leading to frequent career move, whereas employees beyond a certain age may prioritise job stability and work-life balance (Rombaut and Guerry, 2021).

In Malaysia, the logistics industry is also experiencing these issues. Malaysia has experienced an increase in the overall attrition rate, which jumped from 14.9% to 16.2%, from 2022 to 2023, and some sub-sectors recorded turnover rates of more than 90% (Chang et al., 2024; Gonzales, 2024). Although numerous studies have shown that reward satisfaction significantly impacts turnover, few have investigated how age and commuting distance influence this relationship. The gap in our understanding affects how organisations plan staff retention efforts, especially in a field like logistics where manpower remains crucial (Moh, 2023).

2. LITERATURE REVIEW

2.1 Underlying Theory: Herzberg's Two-Factor Motivation Theory

Herzberg's Two-Factor Motivation Theory offers an insightful framework for investigating job satisfaction, rewards, and employee turnover. The theory classifies work factors into two categories including hygiene factors and motivators. Hygienic elements such as wages, safeguards, leadership, rules and regulations, and working circumstances that will prevent job dissatisfaction but not necessarily lead to motivation, whereas motivational elements such as success, praise, accountability, improvement, and advancement will strengthen job satisfaction (Ozdil et al., 2023). Chiat and Panatik (2019) highlighted how people might become demotivated and leave an organization if hygiene components are inadequate, even in the presence of motivators. Rewards and incentives such as bonuses, additional leave, and company trips encourage and motivate employee efficiency (Chiat and Panatik, 2019). Employees who think they are not sufficiently compensated tend to be dissatisfied (Mustafa et al., 2022).

2.2 Rewards Satisfaction and Employee Turnover

Implementing a reward system for employee efforts could enhance motivation and loyalty. According to Tirta and Enrika (2020), rewards satisfaction should be granted based on fair and unbiased judgement, as recognition plays a crucial role in supporting an organization's talent retention efforts. Incentive system is a powerful tool for signaling to employees that their dedication and contributions are valued and recognized (Hosen, 2022). Kurdi, Alshurideh and Afaishat (2020) added that having control over reward outcomes increases task confidence. Nitharshan, Priyantha and Samantha (2016) emphasized that integrating intrinsic and extrinsic rewards promotes a positive working culture and increases retention. Choudhuri (2022) noted that employees who are pleased with their salary and rewards considerably decrease job-seeking behavior, whereas unhappiness with the reward system promotes absconding and turnover. Similarly, Aggarwal (2022) found that rewards compensation has contributed to a 21% increase in employee retention.

2.3 Age and Employee Turnover

Age plays an important role in turnover trends. Ferdous, Ali and French (2021) observed that younger workers are more likely to explore new opportunities and change jobs frequently, while older workers prioritize job security. De Meulenaere, Allen and Kunze (2022) confirmed that age is a significant physical factor influencing job stability. The EY Work Reimagined Survey 2024 found that 38% of Generation Z (born 1997-2012) have indicated they plan to leave their jobs the following year, which was a 4% increase in employee turnover compared with previous years (World Economic Forum, 2025). In contrast, Ali et al. (2025) highlighted that elderly staff emphasize steadiness and psychological satisfaction for long-term job advancement, contributing to lower employee turnover, especially when challenged with unfavorable circumstances at work.

2.4 Workplace-home Distance and Employee Turnover

Workplace-home distance also impacts turnover. Long and unpleasant commutes are a significant reason employees consider resigning, while new hiring may reject job offers with extensive travel

times and lack of travel allowances (Paul, 2024). Atef, Elzanfaly and Ouf (2022) found that turnover rates were highest among those commuting between 21–40 km. Their research confirmed a positive correlation between distance and turnover rates. In the United States, 23% of workers resign due to commute dissatisfaction, particularly within the 18-34 age group (Paul, 2024). It has been demonstrated that workers who live closer to their place of employment tend to stay with the company 20% longer.

3. DISCUSSION

Drawing from the above literature review, it is evident that while reward satisfaction is important in preventing employee turnover, its effectiveness varies between employee groups. The moderating effects of age and workplace-home distance complicate this relationship. For example, younger employees may priorities career progression and skill development higher than rewards, causing them to be hesitant to leave regardless of attractive compensation packages. On the flip side, elderly employee tends to desire job stability and could adapt more positively to long-term rewards such as retirement benefits or job security assurances.

Similarly, long commutes can be a greater challenge than financial incentives for many employees. Employees with longer commute times are more likely to be unsatisfied with their jobs and quit, regardless of how well they are compensated. Therefore, organizations in the logistics industry need to take this into account when developing retention strategies. Providing flexible work arrangements, assistance with transit, or even decentralized logistics centers could all help reduce turnover caused by commutes. Companies may consider age-based career paths or reward systems that are adapted to expectations of different age groups.

In summary, the research indicates that employee retention is not a universal solution. To create an effective retention policy, Logistics companies should incorporate age and workplace-home distance as vital variables in policy designing, in order to increase personnel stability in a competitive and operationally intensive industry.

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Muslim Females' Experience with Male E-Hailing Drivers at Night: A Study at Penang

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ABSTRACT

This study investigates the experiences of Muslim female passengers with male e-hailing drivers during nighttime in Penang, Malaysia. While e-hailing services offer convenience and accessibility (Statista, 2024), significant safety concerns persist for female passengers, particularly Muslim women, due to religious and cultural sensitivities regarding gender interaction. A qualitative, interpretivist methodology was employed using semi-structured interviews with eight Muslim female respondents aged between 22 and 25, who were frequent e-hailing users at night. Thematic analysis revealed three dominant themes: (1) trust challenges and cultural considerations, (2) perceptions of safety and security during nighttime rides, and (3) expectations for safer, gender-sensitive e-hailing services. Notable issues included discomfort with male drivers, concerns over route changes, fear of harassment, and vehicle safety (Acheampong, 2021; Jamaludin, 2021). To manage their concerns, participants commonly adopted coping strategies such as ride tracking and 'digital mahram' practices. Despite these personal measures, respondents expressed a strong preference for structural improvements, including female driver options and stricter driver background checks. They enhanced in-app safety features to ensure a safer and more culturally sensitive e-hailing experience. This study extends the Theory of Planned Behavior (Ajzen, 1991) by integrating religious and cultural dimensions into transport safety discourse and urban mobility policy considerations.

Keywords: Muslim females; E-hailing; Safety concerns; Theory of Planned Behavior; Penang

1. INTRODUCTION

The Malaysian e-hailing sector has seen significant growth (Statista, 2024), with increasing reliance by women, though safety issues persist. Harassment incidents in Southeast Asia's e-hailing sector (Jamaludin, 2021) have intensified Muslim women's concerns over night-time safety, intersecting with religious and cultural expectations regarding modesty and gender interaction.

While previous studies have examined general female safety in transit environments, there is a significant gap in research focusing specifically on Muslim women, whose experiences are uniquely shaped by religious and cultural expectations. In particular, concerns related to modesty, gender interaction, and night-time travel increase their vulnerability when using male-driven e-hailing services. This study addresses this underexplored issue by investigating the personal safety concerns and cultural sensitivities faced by Muslim female passengers in Penang during night-time e-hailing rides.

The Theory of Planned Behavior (Ajzen, 1991) was employed as the guiding framework because it effectively explains how attitudes, subjective norms, and perceived behavioral control influence decision-making in culturally sensitive contexts. In this study, TPB helps to understand how Muslim female passengers' attitudes towards safety, the influence of societal and religious norms, and their perceived control over night-time mobility shape their willingness to use e-hailing services driven by male drivers.

Based on the problem identified and the application of TPB, this study proposed that Muslim females' perceptions of personal safety risks, their trust in the service, and the availability of religiously appropriate options (such as female drivers and gender-sensitive services) would significantly influence their behavioral intentions to engage with e-hailing services at night.

Research Model:

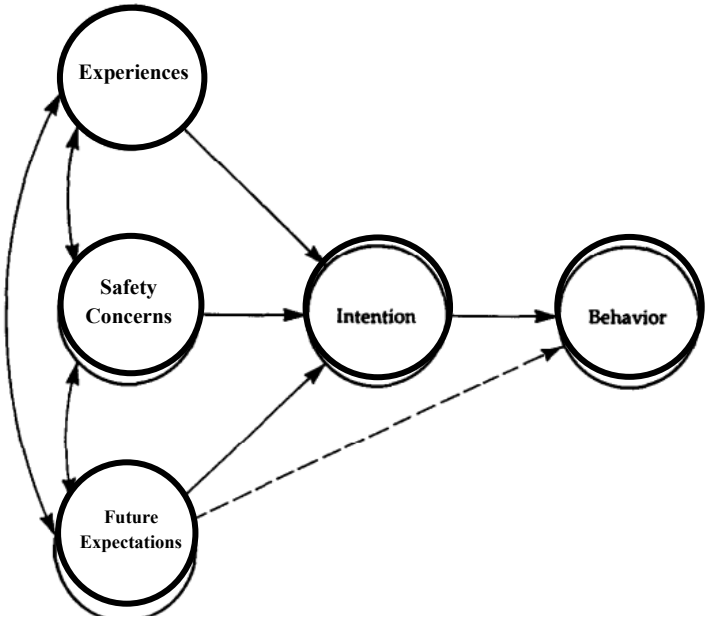

Figure 1 Conceptual Framework Diagram

2. METHODOLOGY

A qualitative, interpretivist design (Ryan, 2018) was selected to explore personal experiences. Purposive sampling targeted Muslim females aged 22–25 in Penang who had used e-hailing services at night within the past six months. Eight participants were interviewed face-to-face using semi-structured interview protocols, covering experiences, safety concerns, and expectations. Each interview lasted between 20 to 40 minutes, allowing participants to express their views in detail. Interviews were transcribed and coded using thematic analysis (Braun and Clarke, 2006). Ethical procedures included obtaining informed consent, ensuring voluntary participation, and maintaining participant anonymity.

3. ANALYSIS AND RESULTS

Theme 1: Muslim females highlighted discomfort with male drivers due to unsolicited personal conversations, modesty concerns, and a preference for female drivers (Shaheen et al., 2016). One participant (P3) shared, *"Most of the time when I use the e-hailing service, I often wear a face mask because they cannot see my face so I think it's safer for me."* Another respondent (P1) expressed, *"The first thing first is about gender because most of the time the driver is male and I do not know what will happen to me because I'm a female and I ride a car with strangers."* This discomfort was further intensified at night due to increased isolation and vulnerability.

Theme 2: Safety concerns were centred on harassment risks, unsafe routes, poor vehicle conditions, and drivers' behaviour at night (Acheampong, 2021; Jamaludin, 2021). One respondent (P1) stated, *"Maybe when a driver took an unfamiliar route without informing me first… that makes me very concerned about my safety."* Another participant (P7) noted, *"Some of the e-hailing cars are not in good condition — there are boxes, laundry, and other items inside, which makes me feel uneasy."* Participants also reported incidents of inappropriate conversations and staring from drivers, heightening their anxiety during rides.

Theme 3: Respondents called for female driver options, stricter driver screening, in-app emergency features, and gender-sensitivity training (Ahmed & Shuvo, 2024). A participant (P7) recommended, *"Definitely an option for women drivers. If I had the option, I would always choose a female driver because it feels safer."* Another added, *"An option for formal driver verification and strict screening should be implemented to improve safety."* Expectations for better safety features were consistent, with one respondent (P6) suggesting, *"A feature that allows passengers to share live ride updates with emergency contacts would make me feel more secure."*

4. DISCUSSION

Results affirmed Ajzen's (1991) TPB model, where religious and cultural expectations uniquely shaped attitudes, norms, and perceived control among Muslim female passengers. Safety fears and Islamic modesty values deterred night-time travel or led to coping strategies such as ride tracking, wearing face coverings, and making phone calls to family during trips. Participants' expectations highlight a strong demand for religiously and culturally sensitive services.

To accommodate Islamic values, e-hailing providers could introduce female-only driver options (Shaheen et al., 2016) or allow female passengers to request female drivers, particularly for night-time journeys specifically. Additionally, incorporating gender preference filters in booking apps would empower Muslim female users to travel more comfortably while adhering to religious guidelines. Service providers could also implement mandatory gender-sensitivity and cultural awareness training for drivers, addressing appropriate communication, personal space boundaries, and passenger privacy (Ahmed & Shuvo, 2024).

In terms of improving security measures, platforms should enhance in-app emergency assistance features such as real-time ride tracking shared with trusted contacts, an SOS panic button directly linked to local authorities, and discreet alerts for passengers in distress (Acheampong, 2021). E-hailing companies should also enforce stricter driver background checks, including screening for criminal records, prior complaints, and vehicle condition audits to ensure safety and professionalism. Regular driver performance reviews, feedback mechanisms for reporting harassment or misconduct, and collaboration with local law enforcement to manage night-time operations could further improve passenger security.

This study has several limitations. It was based on a small, localized sample of eight Muslim female passengers in Penang, which may limit the generalisability of the findings to other regions or demographic groups. Additionally, the study focused solely on the perspectives of passengers, without including insights from e-hailing drivers or service providers. Future research should expand to include larger, more diverse samples covering different age groups, religions, and regions, as well as incorporating the views of male and female e-hailing drivers and policymakers. This would provide a more comprehensive understanding of safety dynamics, gender sensitivities, and service expectations within Malaysia's urban transportation ecosystem.

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Application of IoT Technology in Monitoring Soil Conditions for Gardening and Assisting Optimal Plant Growth

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ABSTRACT

The integration of the Internet of Things (IoT) into sustainable agriculture has emerged as a powerful means to address environmental concerns, reduce water wastage, and ensure effective plant management. This paper presents the development and evaluation of a smart gardening system leveraging IoT technologies to automate irrigation and environmental monitoring. The proposed system was designed to maintain optimal conditions for plant health by utilising sensors that detect soil moisture, temperature, humidity, and light intensity. A microcontroller processes real-time sensor data and communicates with a cloud platform to enable remote monitoring and decision-making. The system activates a water pump when the soil moisture level drops below a predetermined threshold and allows users to receive live updates via a web interface. Emphasis was placed on cost-efficiency, ease of maintenance, and scalability. The analysis demonstrated significant improvements in water usage efficiency, user convenience, and plant vitality. Furthermore, the discussion explores the challenges in sensor calibration, connectivity reliability, and environmental variability, while highlighting future improvements, such as more actuator for different parameters and predictive analytics through AI. Overall, this project validates the practical feasibility of IoT in enhancing small-scale gardening and contributes valuable insight for further developments in automated horticulture systems.

Keywords: Internet of Things; Smart gardening; Soil moisture sensor; Automated irrigation; Remote monitoring

1. INTRODUCTION

The increasing global emphasis on environmental sustainability and food security has led to a surge in interest in smart agriculture. Within this domain, gardening—a smaller but significant component—has witnessed a paradigm shift through the integration of the Internet of Things (IoT). IoT technology enables the development of systems that automate plant care and resource management, particularly water and energy. A smart gardening system, therefore, not only reduces the manual effort required in plant maintenance but also improves efficiency by optimising irrigation schedules and monitoring plant health in real-time (Singh et al., 2021).

Traditional gardening practices depend heavily on human intuition and fixed watering schedules, which can lead to resource inefficiencies and inconsistent plant care. Smart gardening systems, however, respond dynamically to changes in environmental parameters, promoting both plant vitality and water conservation (Kumar et al., 2022). The core objective of this project is to develop a IoT gardening system that automatically controls watering based on real-time environmental data, including soil moisture, humidity, temperature, and sunlight levels. As highlighted in recent works, such systems can significantly reduce water consumption and prevent both overwatering and under watering. Furthermore, remote access and cloud-based data storage enable gardeners to track system

performance and intervene when necessary, even from remote locations. Instead of relying on third-party platforms and applications like Blynk or ThingSpeak, this project implements a custom-designed dashboard hosted locally or online. This dashboard enhances user control, security, and adaptability. The smart gardening system thus serves as an accessible solution for home gardeners and small-scale farmers seeking to adopt modern technology for better horticultural outcomes (Sharma et al., 2020).

This paper details the complete development cycle of the smart gardening system, from component selection and circuit design to software integration and field testing. The study aims to contribute a practical and cost-effective solution to the growing demand for automated gardening systems that are accessible to both enthusiasts and small-scale urban farmers.

2. METHODOLOGY

The development of the IoT-based gardening system was anchored on the use of the ESP32 microcontroller, selected for its integrated Wireless Fidelity (Wi-Fi) capability. Central to the monitoring system is a 7-in-1 soil sensor, capable of measuring key parameters such as moisture, temperature, electrical conductivity, pH, and the concentrations of nitrogen, phosphorus, and potassium. To ensure compatibility with the ESP32, an RS-485 to Transistor–Transistor Logic (TTL) converter was used to handle signal level adjustments, allowing seamless integration between the sensor and microcontroller.

For actuation, the system employs a relay module to control a submersible water pump that irrigates the soil whenever the moisture level falls below a predetermined threshold. The entire system is powered by a 5V regulated supply, meet the voltage requirements of the ESP32 and other components.

Software development was carried out using the Arduino Integrated Development Environment (IDE). The firmware was written in C/C++, utilising libraries such as ModbusMaster to manage RS485 communication with the soil sensor, and WiFi.h to establish a stable internet connection. This project features a bespoke, in-house developed dashboard. The dashboard provides real-time visualisation of soil metrics, remote activation of the irrigation pump, and historical data logging, all accessible through a web interface. Communication between the ESP32 and the dashboard was implemented using Hypertext Transfer Protocol (HTTP), Message Queuing Telemetry Transport (MQTT), Websocket protocols to enable both data transmission and control commands.

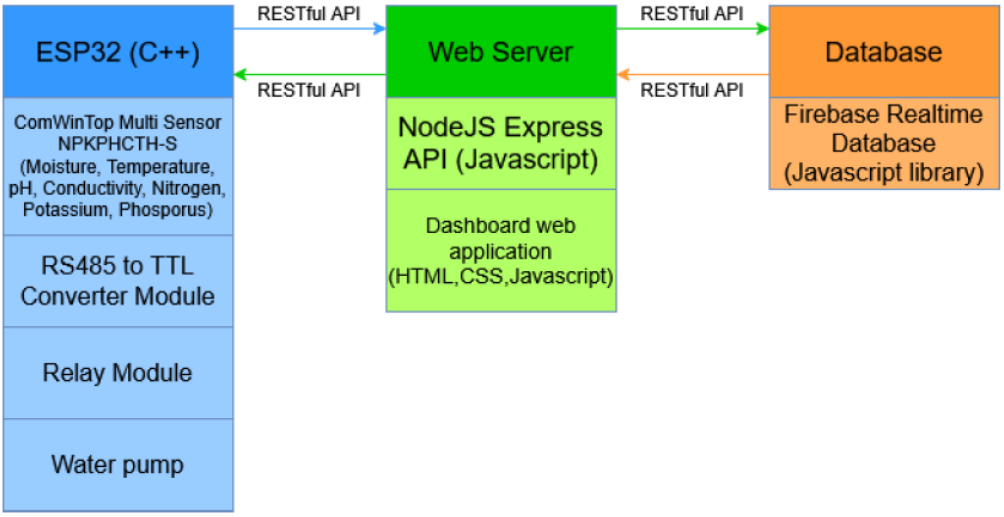

Figure 1 Key System Components and Their Interactions

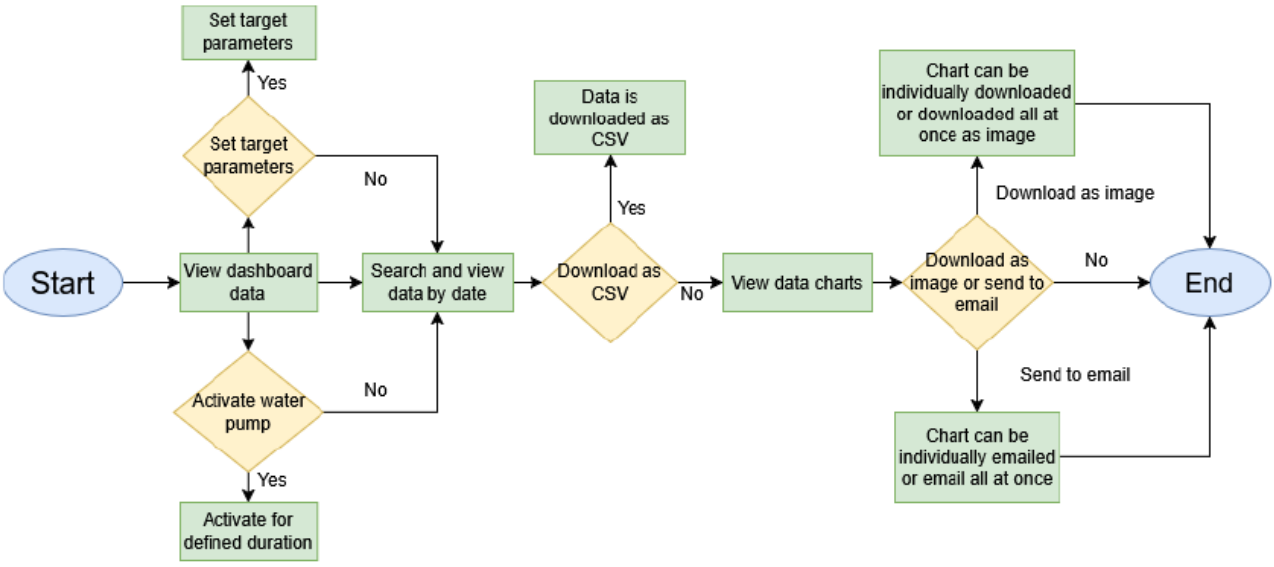

Figure 2 System Flowchart

The 7-in-1 sensor was strategically placed in the root zone of the plant to ensure accurate and consistent readings. Readings were taken every 10 seconds, processed by the ESP32, and then pushed to the web-based dashboard. The logic embedded within the microcontroller constantly compared the real-time moisture data against a predefined threshold. When the soil was detected to be dry where the moisture level below 20%, the ESP32 triggered the relay to activate the water pump for a specified duration, thereby irrigating the plant until satisfactory moisture levels were restored. The system also recorded each watering event, including the time and duration, enabling detailed analysis of irrigation patterns over time.

3. ANALYSIS AND RESULTS

Upon deployment, the system showed consistent performance across all functional modules. The RS485-based soil sensor provided stable readings, with moisture data ranging from 20% to 50% depending on environmental exposure. Irrigation was automatically activated when moisture dropped below the set threshold. This process typically ran for 30–90 seconds before sensor feedback triggered a stop condition.

The custom dashboard successfully reflected real-time updates with a latency of less than one second. The interface proved user-friendly and responsive, supporting graphical visualisation of moisture and temperature data. Unlike third-party dashboards, this in-house solution enabled flexible control over data storage and visual formatting without subscription limits.

Testing over a 10-day period revealed a 55% reduction in water usage compared to fixed-schedule manual watering. Nutrient readings were captured for each cycle, though not yet utilised for fertilisation control. The sensor data could be used in future versions to automate nutrient delivery based on plant needs.

```
PS C:\Users\ASUS\Desktop\Assignments\Year3\Final Year Project\FYP_Development\Application> npm test

> esp-32-api@1.0.0 test
> jest

 PASS  test/api.test.js
  API routes
    √ GET /getLastLoggedData - success (22 ms)
    √ GET /getLastLoggedData - database error (6 ms)
    √ GET /getSensorData/:date - success (7 ms)
    √ GET /getSensorData/:date - no data found (4 ms)
    √ POST /sendData - success (14 ms)
    √ POST /sendData - error (4 ms)
    √ GET /getParameters - success (4 ms)
    √ POST /setParameters - success (4 ms)

Test Suites: 1 passed, 1 total
Tests:       8 passed, 8 total
Snapshots:   0 total
Time:        1.203 s, estimated 2 s
Ran all test suites.
PS C:\Users\ASUS\Desktop\Assignments\Year3\Final Year Project\FYP_Development\Application>
```

Figure 3 Unit Tests Successfully Running

Unit testing was carried out using Jest and Supertest to verify that the core backend routes were working correctly in isolation. These tests validated the server's responses for success and failure conditions as shown in Figure 3.

The dashboard successfully logged and displayed real-time sensor data, confirming the reliability of both the hardware and software components. On startup, the dashboard automatically retrieves last received sensor readings through the /getLastLoggedData endpoint to initially display on dashboard as shown in Figure 4.

WebSocket is used for enabling live updates without the need for manual refreshes. Every time new data is received, dashboard dynamically updates values on screen with the received data. Additionally, target parameters being set allows for text highlighting when the values aren't within desired thresholds.

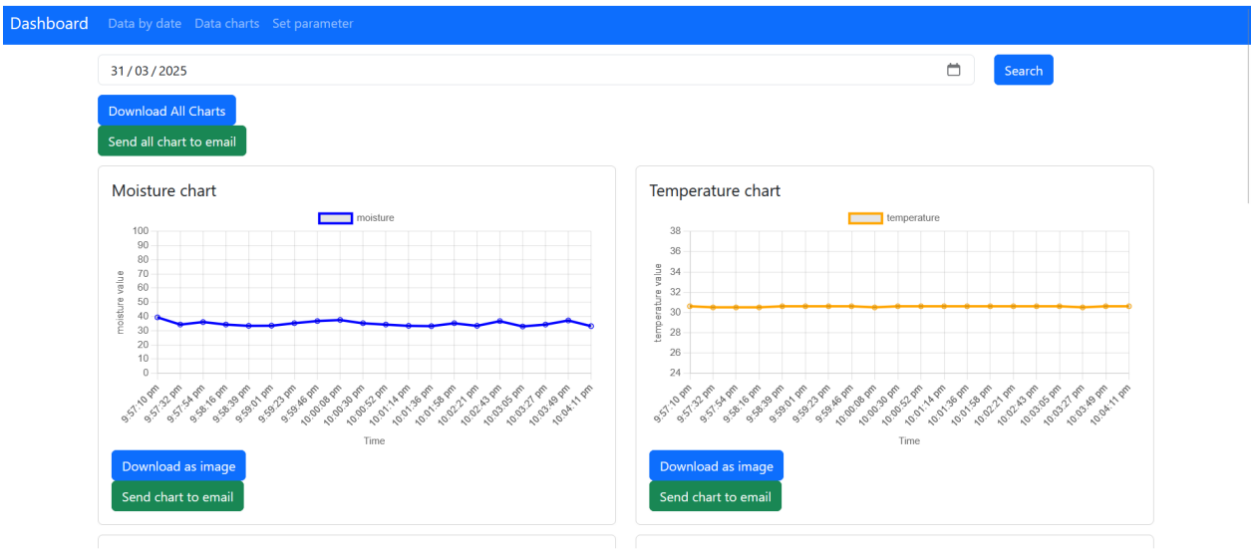

Figure 4 Data Charts

4. DISCUSSION

This study demonstrates how IoT-based gardening systems can improve plant care and water management. By integrating ESP32 with industrial-grade RS485 soil sensors and a web-based dashboard, the system provides a reliable, low-maintenance solution for automated irrigation. The use of RS485, while requiring additional hardware, proved beneficial data for better monitoring system (Zhang et al., 2023).

The use of a custom dashboard enabled greater control, reduced dependence on cloud platforms, and addressed privacy concerns. Unlike typical solutions tied to commercial APIs or limited visualisation features, the local dashboard is scalable and adaptable for advanced applications such as AI-based irrigation forecasting.

Despite its advantages, challenges included sensor calibration complexity and system dependence on Wi-Fi connectivity. Soil variability also affects pH and conductivity readings, which may require adaptive thresholds based on plant type or region. Integrating machine learning models in future versions could provide predictive analytics for irrigation and fertilisation based on historical trends and external weather forecasts (Chen et al., 2021).

For long-term sustainability, actuator mechanisms that able to improve other parameters conditions can be explored. Moreover, incorporating alert systems via app notifications would enhance user engagement and fault tolerance.

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ScholarChain: Blockchain Driven Framework for E-Transcript Validation

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ABSTRACT

Academic credential verification remains a slow, manual process prone to forgery and inefficiency. ScholarChain addresses this by introducing a blockchain-based secure and real-time e-transcript authentication framework. The system enables universities to issue tamper-proof transcripts, students to manage and share credentials, and employers to verify them instantly without intermediaries. Using Ethereum smart contracts on the Sepolia testnet, MongoDB Atlas for data storage, and a modular frontend-backend architecture, ScholarChain ensures data immutability, transparency, and integrity. An additional innovation includes blockchain-based digital badges awarded to students for academic milestones, increasing engagement and recognition. Functional, integration, and security testing validated the system's usability and robustness. While challenges such as smart contract immutability, gas fees, and technical barriers for non-expert users were identified, the solution demonstrates high potential for transforming academic verification. Future development will focus on mainnet deployment, smart contract upgradability, and broader gamification.

Keywords: Blockchain; E-Transcript; Verification System; Smart Contracts; Gamification

1. INTRODUCTION

1.1 Background of the Study

Traditional transcript verification is slow, manual, and prone to fraud, especially in an increasingly digital and global job market. ScholarChain addresses these inefficiencies by introducing a blockchain-based framework that enables universities to issue tamper-proof transcripts, students to manage and share them securely, and employers to verify them instantly. Built on Ethereum smart contracts and InterPlanetary File System (IPFS), the system ensures transparency, data integrity, and decentralized control.

1.2 Problem Statement

Three key issues drive the need for ScholarChain: (i)inefficient verification, where manual and error-prone processes delay hiring and invite fraud; (ii)lack of standardization and security, as unencrypted, inconsistent transcript formats make validation unreliable; (iii)lack of engaging recognition, since traditional transcripts fail to showcase unique student achievements, reducing motivation and visibility.

1.3 Underlying Theory

Based on blockchain and distributed trust theory, ScholarChain uses Ethereum smart contracts for automation and IPFS for decentralized file storage. Web3.js links these backend components to a user-friendly frontend, reducing reliance on centralized authorities and increasing system trustworthiness.

1.4 Hypotheses Development and Research Model: This study is guided by the following hypotheses: **H1**: Blockchain reduces academic fraud through credential immutability; **H2**: A standardized framework enhances verification efficiency and trust; **H3**: Digital badges boost student

motivation and visibility. Research Model: In the proposed model, universities issue credentials via smart contracts, students manage them through a web app, and employers verify them on-chain, hence creating a secure, decentralized validation ecosystem.

2. METHODOLOGY

The project employed a design science research methodology (DSRM) to develop and evaluate ScholarChain as a functional solution to transcript verification issues. An Agile Scrum framework enabled iterative development, testing, and feedback across defined sprint cycles. A purposive sampling strategy was used, simulating real-world roles for universities, students, and employers using fictitious transcript data and system workflows. Data was gathered via functional, integration, and usability testing on the deployed prototype using the Ethereum Sepolia testnet. Transcript issuance and verification actions were monitored to assess responsiveness and error handling. The ScholarChain system was developed using a combination of modern web and blockchain technologies. Smart contracts written in Solidity enabled on-chain issuance and validation of transcripts. A React.js frontend, integrated with MetaMask, facilitated user interactions, while the Node.js backend managed application logic and user data, supported by MongoDB Atlas for secure off-chain storage. IPFS was used to store transcript files in a decentralized manner, and Web3.js enabled seamless communication between the frontend and the Ethereum blockchain. Quantitative metrics such as transaction success rate, and verification accuracy were recorded. Qualitative feedback from user testing helped assess usability and the impact of gamification features like digital badges.

3. ANALYSIS AND RESULT

The ScholarChain system was successfully developed and tested, demonstrating secure, real-time academic transcript verification using blockchain. Functional testing showed that universities could issue transcripts, students could retrieve them, and employers could validate authenticity through hash or Quick Response (QR) code, all with a 100% success rate on the Ethereum Sepolia testnet.

Table 1 Transcript Issuance and Verification Performance

Test Scenario	Success Rate (%)	Observations
Issuing transcript to blockchain	100%	Executed without failure
Student access via dashboard	100%	Smooth display via Web3 connection
Employer verification via QR	100%	Verified instantly on Sepolia chain

The system's React.js frontend, integrated with MetaMask, provided a seamless user experience for all stakeholders. Gamification features were effectively implemented through blockchain-issued digital badges that students could view in their dashboard and share professionally. Security tests confirmed that unauthorized access attempts were blocked, highlighting the robustness of the smart contract-based access controls.

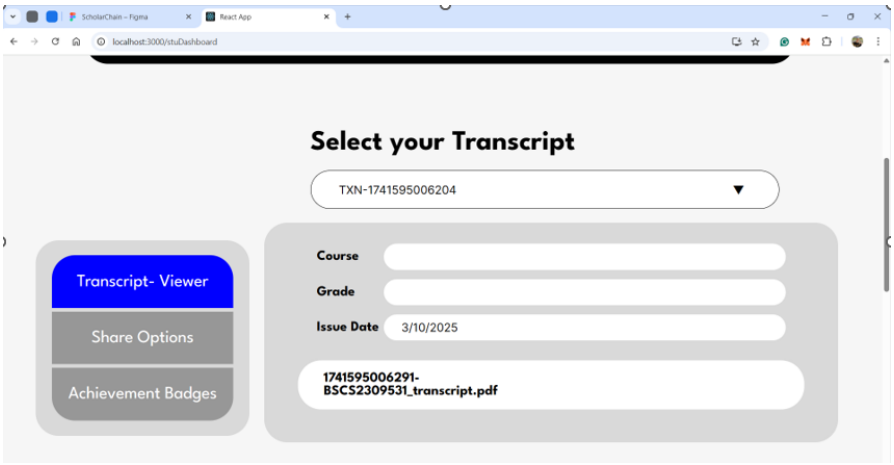

Figure 1 Student dashboard showing transcript

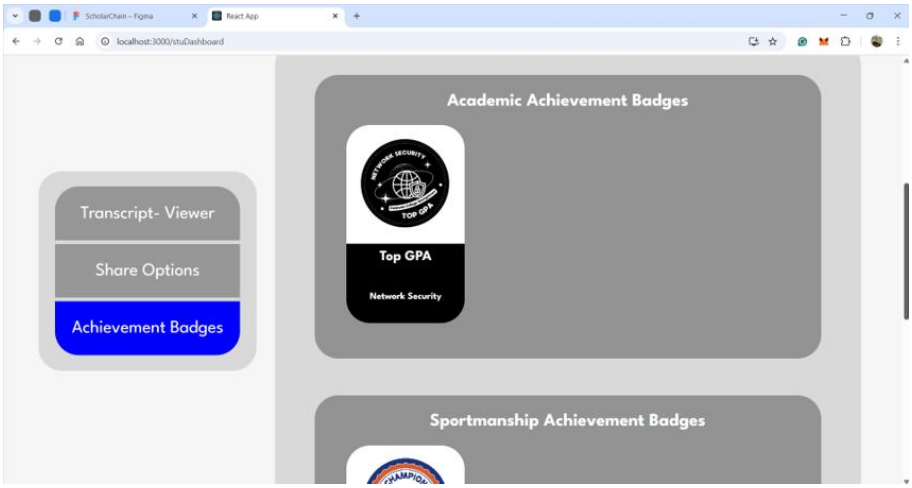

Figure 2 Student dashboard showing the badge display

4. DISCUSSION

ScholarChain's findings align with earlier studies as presented in (Alammary et al., 2019; Akyildiz et al., 2020) that demonstrate blockchain's effectiveness in securing academic credentials. Unlike prior systems, ScholarChain introduces gamified digital badges, filling a gap in student engagement and recognition. Theoretically, this project contributes to the evolving field of decentralized trust models by applying blockchain and smart contracts to academic validation—a domain historically controlled by centralized institutions. It supports the theory that immutable, distributed ledgers can replace manual verification processes in trust-dependent systems. Practically, ScholarChain enhances transparency and reduces credential fraud, offering real-time, reliable verification to employers while cutting down administrative burden for universities. Students benefit from faster credential sharing and the ability to showcase achievements beyond CGPA through digital badges. While ScholarChain demonstrates strong potential, it has certain limitations. The immutability of smart contracts makes it difficult to correct errors after deployment, which can affect maintainability. The system also relies on blockchain tools like MetaMask, which may be challenging for users unfamiliar with web3 technologies. Additionally, the use of third-party platforms such as IPFS and Sepolia introduces external dependencies. Most importantly, ScholarChain has yet to be tested in real institutional settings, so its integration with legacy university systems and large-scale scalability remains uncertain.

Future improvements could include introducing upgradable smart contracts to enhance flexibility and reduce risks during updates. Exploring Layer-2 solutions like Arbitrum may help lower gas costs and improve transaction speed. The gamification features can be expanded to include more dynamic elements such as leaderboards or peer-endorsed badges. Real-world university pilots should be conducted to test usability and integration. In the long term, creating a consortium-based model would support broader institutional adoption and standardization.

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CloudChain: Integrating Blockchain systems with MANET

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ABSTRACT

The rise of digital governance demands a secure, transparent, and accessible voting infrastructure. This study presents *CloudChain*, a decentralized e-voting system that integrates blockchain technology with Mobile Ad-Hoc Networks (MANETs). Designed using Golang and MongoDB, the system leverages a permissioned blockchain architecture to ensure tamper-resistance, vote immutability, and voter anonymity. A blockchain network is a continuously growing chain of blocks. Therefore, the network is fully dynamic any mobile node can join or leave the network at any time. The incorporation of Proof of Authority consensus within segmented MANETs environments ensures consistent validation despite frequent network partitioning and node mobility. The architecture emphasizes fault tolerance, redundancy, and scalability through modular node design and isolated private databases, enabling real-time vote synchronization and disaster recovery. Security is reinforced through SHA-256 hashing, AES encryption, and recommended enhancements like TLS communication and multi-signature validation. The methodology adopts an Agile development model, iterating through sprints to implement, test, and secure blockchain nodes. Evaluation reveals strong performance in decentralization, integrity, and accessibility, though challenges persist in achieving seamless synchronization and conflict resolution under high mobility. The system presents a promising approach for secure e-voting in rural and disconnected environments, with implications for legal, ethical, and professional standards in modern democracies. CloudChain is positioned as an innovative solution addressing the intersection of trust, decentralization, and offline accessibility. The technology choices such as Golang, MongoDB, permissioned blockchain, and PoA, are justified by their efficiency**,** lightweight operation, and suitability for MANETs. By highlighting security such as AES and SHA-256 along with resilience mechanisms including fault tolerance, disaster recovery, the system is presented as robust and future-ready. The Agile model is justified for its flexibility in refining system features and responding to evolving technical constraints. Furthermore, the discussion on ethical, legal, and professional implications aligns CloudChain with current demands for responsible digital governance**.**

Keywords: Blockchain; E-Voting; MANET; Decentralization; Cybersecurity

1. INTRODUCTION

The electoral process is undergoing rapid digital transformation driven by technologies like blockchain and cloud computing. These technologies promise secure, auditable, and efficient systems. Blockchain, with its decentralized and tamper-resistant structure, is ideal for maintaining trust in electoral records, without the need for a centralized, third party. (Agbo et al., 2019) However, challenges such as dynamic topology, regulatory compliance, and scalability arise when implementing such systems in MANET environments. This study proposes CloudChain, a permissioned blockchain model operating over MANETs, with a focus on creating a secure, scalable, and accessible e-voting framework. A research model integrating Proof of Authority consensus, SHA-256 hashing, and AES encryption within segmented blockchain networks was developed.

This paragraph establishes the technological context and identifies the gap in applying blockchain in MANET-based voting. While blockchain ensures auditability, MANETs complicate reliability due to node mobility and intermittent connectivity. CloudChain is introduced as a solution explicitly engineered to handle such volatility. The use of permissioned blockchain addresses regulatory control, while PoA ensures low-latency consensus in semi-trusted environments. The inclusion of SHA-256 and AES cryptography highlights a defense-in-depth approach for maintaining data confidentiality and integrity.

2. METHODOLOGY

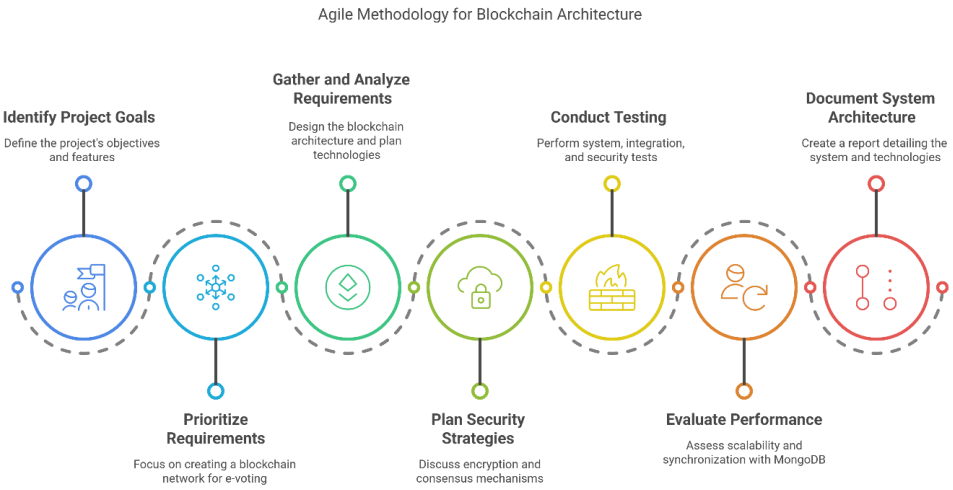

Figure 1 Agile Methodology for CloudChain

This project adopted the Agile software development methodology, dividing the system development into three iterative sprints. Each sprint targeted a critical component of the blockchain-based e-voting system integrated with Mobile Ad-Hoc Networks (MANETs).

The research design centered on a segmented blockchain architecture, where each node—representing a voting terminal—was connected to a local MongoDB instance. These segments simulated distinct voting zones, communicating through a MANET framework to support decentralization, scalability, and offline operation.

A simulation-based sampling technique was used to model real-world election environments, with virtual nodes and segments enabling redundancy and independent validation.

Data collection involved simulating voter registration, vote casting, block creation, and storage. Development was done in Golang, utilizing built-in support for SHA-256 hashing and AES encryption. MongoDB served as the backend for secure, schema-less storage and disaster recovery.

The research instruments included a custom-built blockchain with secure block chaining, Proof of Authority (PoA) for validator-based consensus, AES for vote data encryption and SHA-256 for ensuring integrity and immutability.

Statistical analysis tracked performance metrics like block creation time, sync accuracy, and validation latency. Input validation and error logging were incorporated to evaluate system robustness under typical MANET challenges, including partitioning and intermittent connectivity.

This section justifies the Agile approach, which is critical for managing a complex, multi-layered system like CloudChain. Agile allows continuous adaptation, especially valuable when integrating blockchain with volatile MANET conditions. Segmenting blockchain nodes mirrors real-world

electoral districts, enabling scalable decentralization and localized autonomy. Golang's efficiency and native cryptographic libraries streamline secure development, while MongoDB ensures fast data handling and schema flexibility, which is ideal for various voting data structures.

3. ANALYSIS AND RESULTS

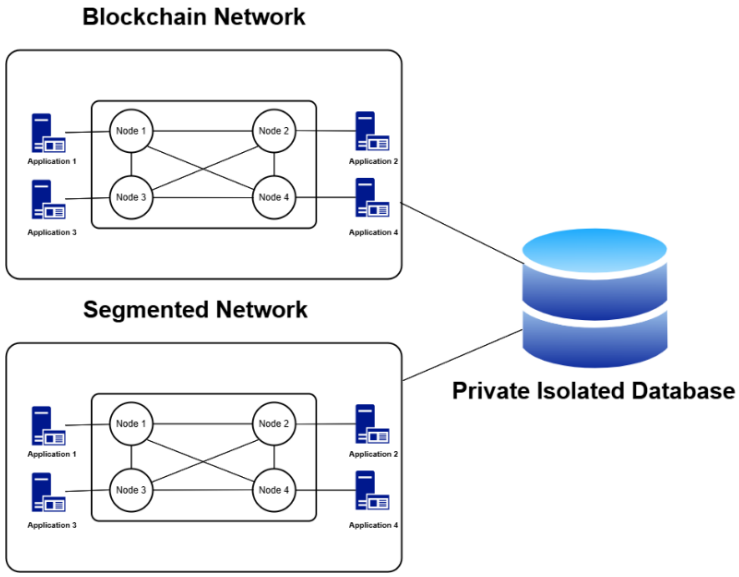

Figure 2 CloudChain Architecture Design

Table 1 Types of Consensus Mechanisms

Consensus Mechanisms	Uses Mining	Validator Type	Ideal for voting
Proof of Work	Yes	Miners	No
Proof of Stake	No	Validators	No
Delegated PoS	No	Elected delegates	Yes
Proof of Authority	No	Pre-approved validators	Yes

The *CloudChain* system was evaluated in a simulated MANET environment to test its performance in decentralized e-voting. Each vote was successfully encrypted, hashed, and stored as a unique block, both on the blockchain and in a local MongoDB instance—supporting redundancy and offline operation.

Testing during network partitioning confirmed that nodes continued to function independently, validating transactions locally. However, upon reconnection, delays in synchronizing blockchain data with the MongoDB backup were observed, revealing a need for improved conflict-resolution and sync mechanisms.

Figure 2 demonstrates how the decentralized structure supports secure, local vote validation and eventual re-integration with other network segments. Meanwhile, Table 1 underscores that PoA is well-suited to semi-trusted environments where node identity can be managed and validated by an electoral authority.

Performance results showed fast block generation recording under 2 seconds, stable cryptographic operations, and consistent throughput across segments with up to 50 users each. Despite strong decentralization and fault tolerance, enhancements in synchronization and threat detection are needed for deployment in real-world, mobile election scenarios.

Overall, the results validate the architectural choices made in CloudChain, particularly the use of segmented blockchain nodes backed by isolated databases and a permissioned consensus model. While the system demonstrates strong performance in decentralization, data integrity, and fault tolerance, improvements are necessary to enhance real-time synchronization and address security mechanisms during network re-integration.

The analysis confirms CloudChain's success in delivering core blockchain functions—encryption, hashing, and decentralized storage—even under network fragmentation. Storing data in both the chain and MongoDB enhances resilience and auditability. The observed synchronization delays upon network reconnection expose a typical MANET challenge, justifying future work on conflict-resolution protocols. PoA's suitability is revalidated by the high throughput and efficiency, especially when scalability is considered.

4. DISCUSSIONS

The *CloudChain* architecture demonstrated a viable solution for decentralized e-voting by integrating blockchain with MANETs, particularly in rural or infrastructure-limited regions. The system effectively ensured data integrity and voter confidentiality using SHA-256 hashing and AES encryption, while PoA consensus supported efficient block validation despite MANET instability.

Theoretically, the project confirms that permissioned blockchains with segmented architecture can operate reliably in mobile, resource-constrained environments. Practically, the use of MongoDB for off-chain storage enhances auditability and aligns with data protection standards like PDPA and GDPR.

Key limitations included synchronization issues during network disconnections, lack of conflict-resolution and advanced threat detection, and vulnerabilities in input handling. Attacks like Double-Spending could be prevented if all nodes are tightly synchronized. (Gervais et al., 2016) Future enhancements should address these through mechanisms like Byzantine Fault Tolerance (BFT), AI-based anomaly detection, and secure database-blockchain reconciliation. Legal features such as voter consent and role-based access should also be expanded to support scalable, cross-border use.

The discussion reinforces CloudChain's relevance for real-world rural voting, with a design that preserves trust and privacy under volatile conditions. Its practical alignment with global data protection laws strengthens its credibility for international deployment. Recognizing limitations like synchronization and threat detection demonstrates academic honesty while identifying clear areas for improvement—including legal infrastructure and AI integration.

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Shipmate: Student Peer-To-Peer Service System

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ABSTRACT

This paper presents Shipmate, a web-based peer-to-peer service platform designed specifically for students of The Ship Campus. The system allows users to offer and request services within a secure and student-verified environment. Key features include real-student verification, service listing, service application with status tracking, a messaging system, and an anonymous rating and review system. This paper follows a structured Web Development Lifecycle, encompassing research, design, implementation, and testing phases. It adopts client-server architecture using Next.js (React) on the frontend and Node.js with Express on the backend, with MongoDB as the database and Auth0 for secure authentication. Manual and automated testing were conducted to assess system reliability. Out of 21 manual test cases, 20 passed and 1 failed, due to non-real-time messaging. Additionally, all 31 unit tests for backend controllers passed successfully. While the system successfully delivers its core functions, some limitations such as the absence of real-time chat and admin role management were identified. Future enhancements are proposed to address these. The development of Shipmate has not only achieved its technical objectives but also contributed significantly to the developer's growth in full-stack development, architectural planning, and resilience in overcoming personal and technical challenges.

Keywords: Shipmate; Peer-to-Peer; Web-based

1. INTRODUCTION

The rise of peer-to-peer (P2P) service systems has highlighted the need for more efficient, student-centered platforms in academic environments. Shipmate: Student Peer-to-Peer Service System aims to create a structured digital marketplace at Ship Campus where students can offer or request services such as tutoring, event support, or transportation. Unlike informal methods like word-of-mouth or social media, Shipmate provides a centralized, accessible solution to enhance service exchange, skill development, and community building. Supported by research on collaborative learning and P2P interaction, the platform is designed to improve student engagement, resource utilization, and overall campus experience in an increasingly digital university landscape.

In the current college environment, the methods for students to exchange services and seek help are often fragmented and ineffective. Communication regarding available services typically occurs through informal channels, such as word-of-mouth referrals and social media platforms like WhatsApp. This lack of a dedicated platform for service exchange limits the ability of students to connect with one another effectively. As demonstrated in Figure 1, which illustrates the likelihood of students using a dedicated platform for finding or offering services, there is a significant interest in a more structured solution.

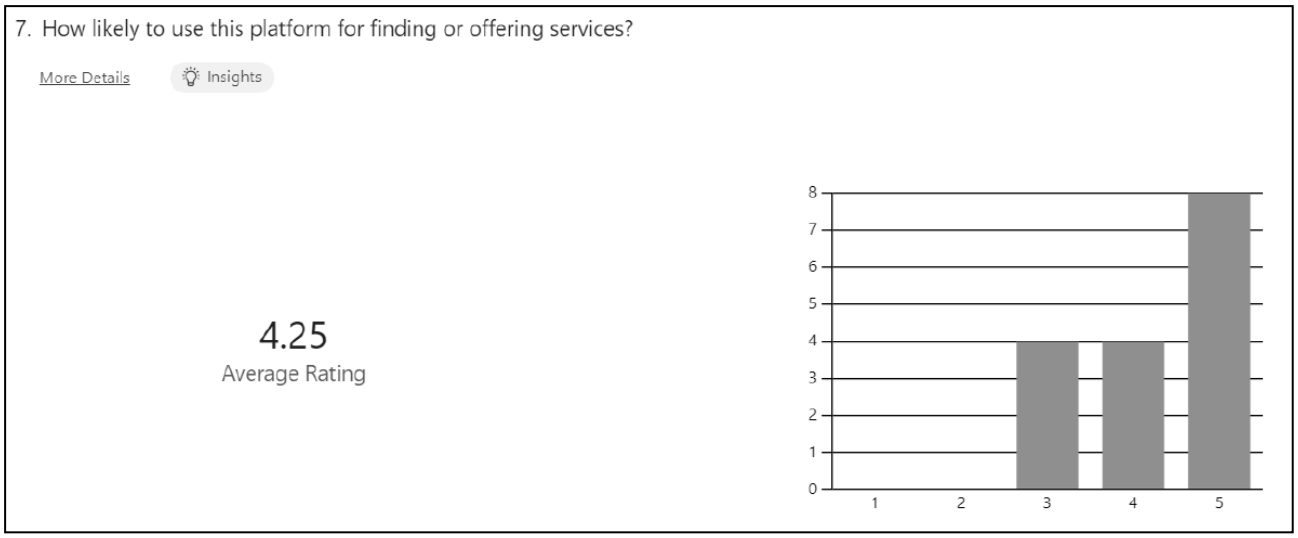

Figure 1 Likelihood of using the Shipmate platform for service exchange

Additionally, while students may be willing to engage in service transactions, the quality of these services can often be uncertain, particularly when dealing with unfamiliar providers. This uncertainty highlights the need for features that foster trust and accountability within the platform, such as identity verification and a rating/review system. Figures 2 and Figure 3 underscore the importance of these features in enhancing user confidence and ensuring reliable experience for both service seekers and providers.

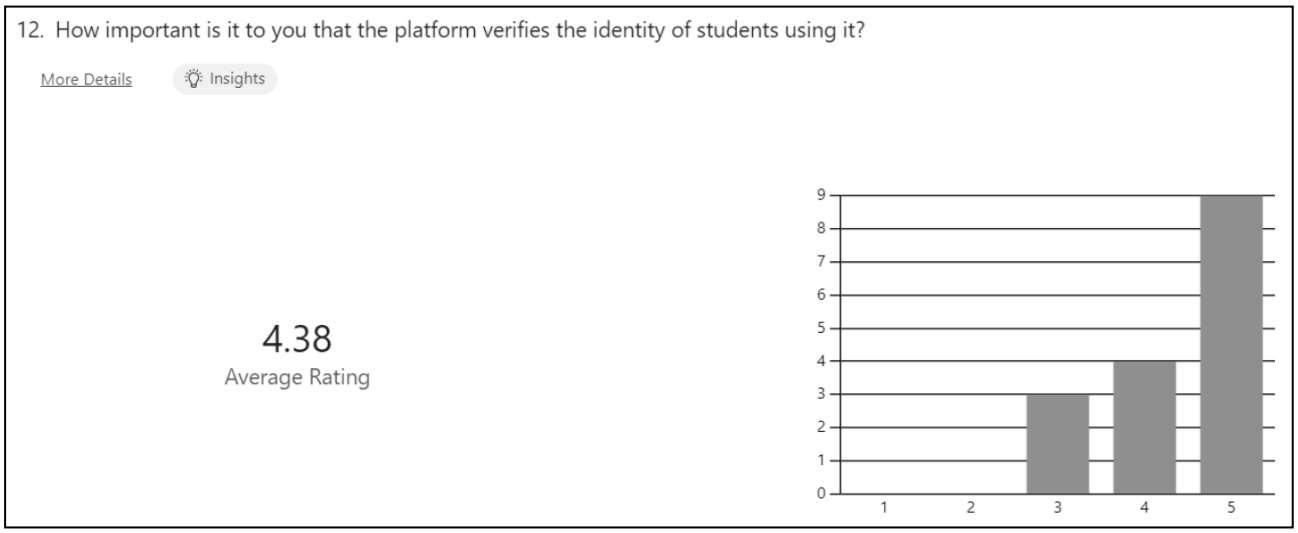

Figure 2 Importance of Identity Verification for Users on the Shipmate Platform

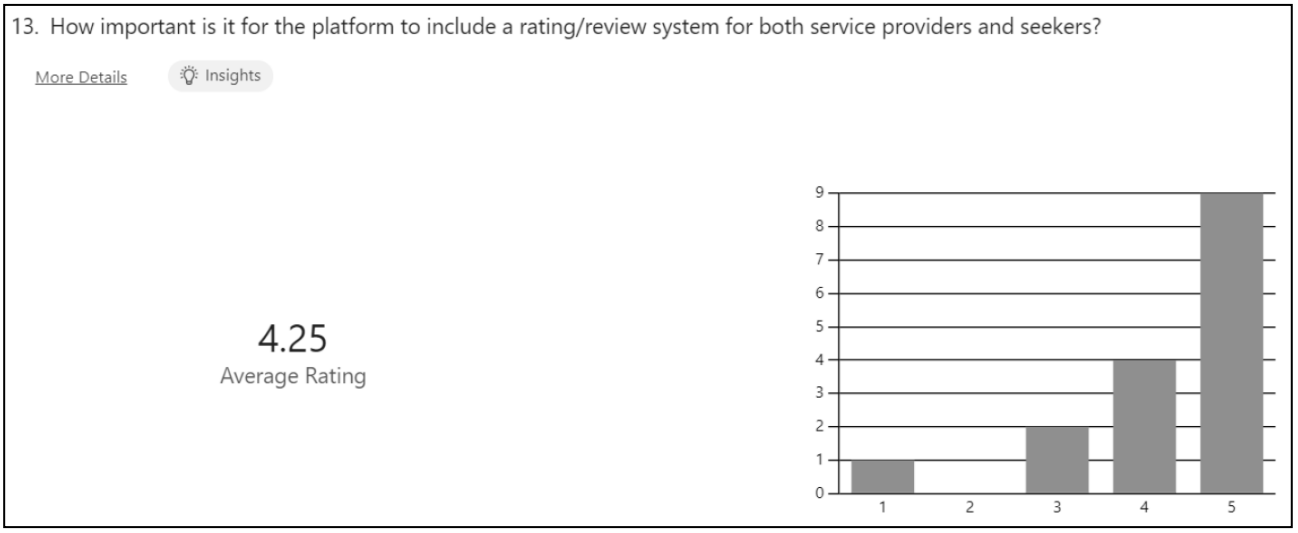

Figure 3 Significance of Rating and Review Systems for Service Providers and Seekers on the Shipmate Platform

Furthermore, the issue of inefficient service discovery and matching among students exacerbates the problem. Many students are unaware of the services available to them or the skills their peers possess. This disconnect can prevent students from seeking help or offering their services when they can make valuable contributions. By implementing a platform that facilitates better visibility of available services and skills, we can bridge this gap and enhance collaboration within the student community.

The research of Stooket, TaskRabbit, and Fiverr yielded crucial insights into effective practices and potential issues in digital marketplace design. Each platform, while unique in scope and audience, provides valuable elements, whether in security protocols, ease of use, or functional organization, that can inform the development of Shipmate. Importantly, comparative analysis serves not as an attempt to surpass these established platforms but as a source of inspiration and guidance, ensuring that Shipmate remains focused on its unique value proposition as a local, student-specific marketplace. Table 1 below shows the results of the comparison.

The problem statements addressed in this work are threefold. First, the fragmented communication channels for service exchange. Second, lack of trust and accountability in service transactions, as indicated by the need for verification and review features. Lastly, inefficient service discovery and matching among students, leading to missed opportunities for assistance and support.

The main objectives of this paper are as follows: to design a system that outlines the structure, features, and user interactions necessary for facilitating peer-to-peer service exchanges among students at The Ship Campus, to develop a platform that implements the designed system, providing a functional web-based solution where students can offer and request services within the campus community and to evaluate the platform's usability and effectiveness in streamlining peer-to-peer service exchanges among students, ensuring it meets user needs and improves service accessibility on The Ship Campus.

Table 1 Comparison of existing products

Feature/Aspects	Stooket	TaskRabbit	Fiverr	Shipmate
Target Audience	UMPSA students	General users, small business	Global freelancers and businesses	The Ship Campus Students
Service Type	Peer-to-peer marketplace	Task outsourcing	Freelance services	Peer-to-peer student services
Focus	Local (UMPSA)	Local (City/Area-specific)	Global	Local (Ship Campus)
Business Model	Low-cost, free for users	Commission-based	Commission-based	Low-cost, free for students
Key Features	Classifieds, Service	Task posting, bidding	Gigs, portfolios, ratings	Student services, job board-style, ratings
Platform Usability	Simple, student-friendly	Simple but more task-focused	Flexible with categories	Simple, student-focused layout
Verification Process	University ID + phone number	ID, background check	No strict verification	School email and Student ID
Transaction Model	Peer-to-peer, direct payment	Payments handled by platform	Payments handled by platform	Direct student-to-student payments
Mobile Interface	Mobile-friendly	Mobile app available	Mobile app available	Mobile-friendly
Strengths	Local, tailored for students	Task-based, flexible	Wide variety of global services	Highly localized, focused on student needs
Limitations	Limited to UMPSA students	Limited to certain tasks/area	Quality control, services fees	Limited to Ship Campus students

2. METHODOLOGY

The Web Development Lifecycle (WDLC) methodology was used in the development of Shipmate to direct the orderly design, development, and progression of the site as shown in Figure 4. WDLC is especially suited for web-based systems likes Shipmate because it breaks the development process into well-defined steps that allow for comprehensive analysis, consistent design standards, efficient implementation, and space for iterative improvement (Aripradono, 2022).

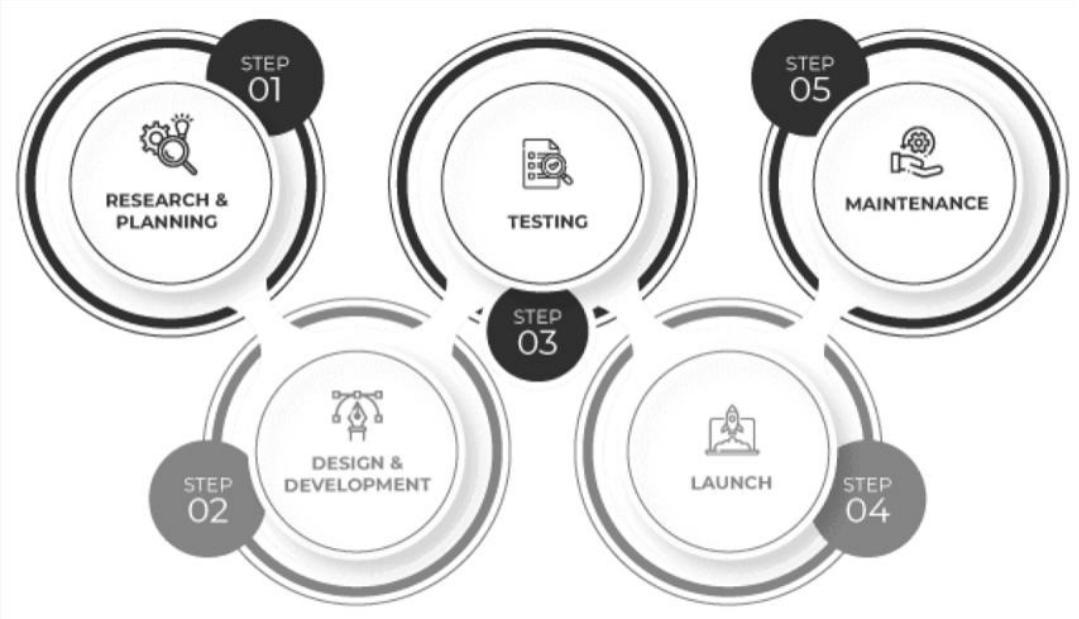

Figure 4 Web Development Lifecycle methodology overview

By following WDLC, this paper structured from concept through deployment, facilitating requirement management, user need fulfilment, and long-term maintainability assurance. This approach facilitates modular development, allowing for ongoing feedback and improvement, which aligns well with Shipmate's ever-changing nature as a peer-to-peer student service platform with multiple interactives features such as messaging and application management (Aripradono, 2022)The initial phase of the development lifecycle focused on understanding the problem, gathering user requirements through surveys, and setting clear objectives for Shipmate, a centralized peer-to-peer service marketplace for students. This step involved identifying student pain points in current service exchanges, narrowing this paper's scope to prioritize student verification, organized service posting, and integrated communication. Key deliverables included detailed requirement documentation, a task breakdown for development, selection of the technology stack, and foundational planning for system architecture and interface wireframes.

The second phase involved implementing the planned design, converting it into functional frontend and backend components. Frontend development utilized React with .tsx files to create a modular and reusable component system, incorporating context providers for global state management and utility functions for formatting. Backend development, using Node.js with Express, established a RESTful API with controllers for business logic, routes for endpoints, and Mongoose for data schema definition. Development progressed incrementally with feature branches, prioritizing user authentication and verification (Auth0), service posting and browse, service application and status management, and chat/messaging. Local testing and version control were consistently applied, enabling independent yet connected development of the frontend and backend via API routes.

The third development phase focused on comprehensive testing, conducted at multiple levels. Manual testing evaluated user flows and various scenarios, especially for finalized frontend features. Peer testing involved group members assessing each other's modules to uncover edge cases and potential issues. Integration testing ensured data consistency between the client and backend, crucial for features like application statuses and real-time chat. Finally, post-completion walkthroughs simulated real-world usage to ensure seamless component transitions. All identified issues were logged and resolved iteratively, leading to a robust system by the end of the development process.

The final development phase focused on deployment readiness and demonstration of the Shipmate system. Although developed locally, the system's modular structure allows for easy transition to production environments. This stage also involved creating documentation, user manuals, and code cleanup. While the current version is stable for presentation, future maintenance considerations include potential enhancements like advanced real-time chat, an admin dashboard for service moderation, and improved analytics. The modular codebase design facilitates future growth, enabling seamless integration of new features and efficient bug fixing.

3. ANALYSIS AND RESULTS

The first objective, to outline the structure, features, and user interactions necessary for facilitating peer-to-peer service exchanges. The system was designed with a client-server architecture, using Next.js (React) for the frontend and Node.js with Express for the backend. MongoDB was used as the database, and Auth0 for authentication. Key features included real-student verification, service listing, service application with status tracking, a messaging system, and an anonymous rating and review system.

The second objective is to develop a functional web-based platform that implements the designed system, allowing students to offer and request services within the campus community. The development followed a structured Web Development Lifecycle (WDLC). The platform provides interfaces for users to discover and browse services, manage their service posts, view applicants, track requested services, and utilize a one-on-one messaging system. Student verification is implemented to restrict service posting to legitimate students. Screenshot of the main key feature for the system is shown in Figure 5.

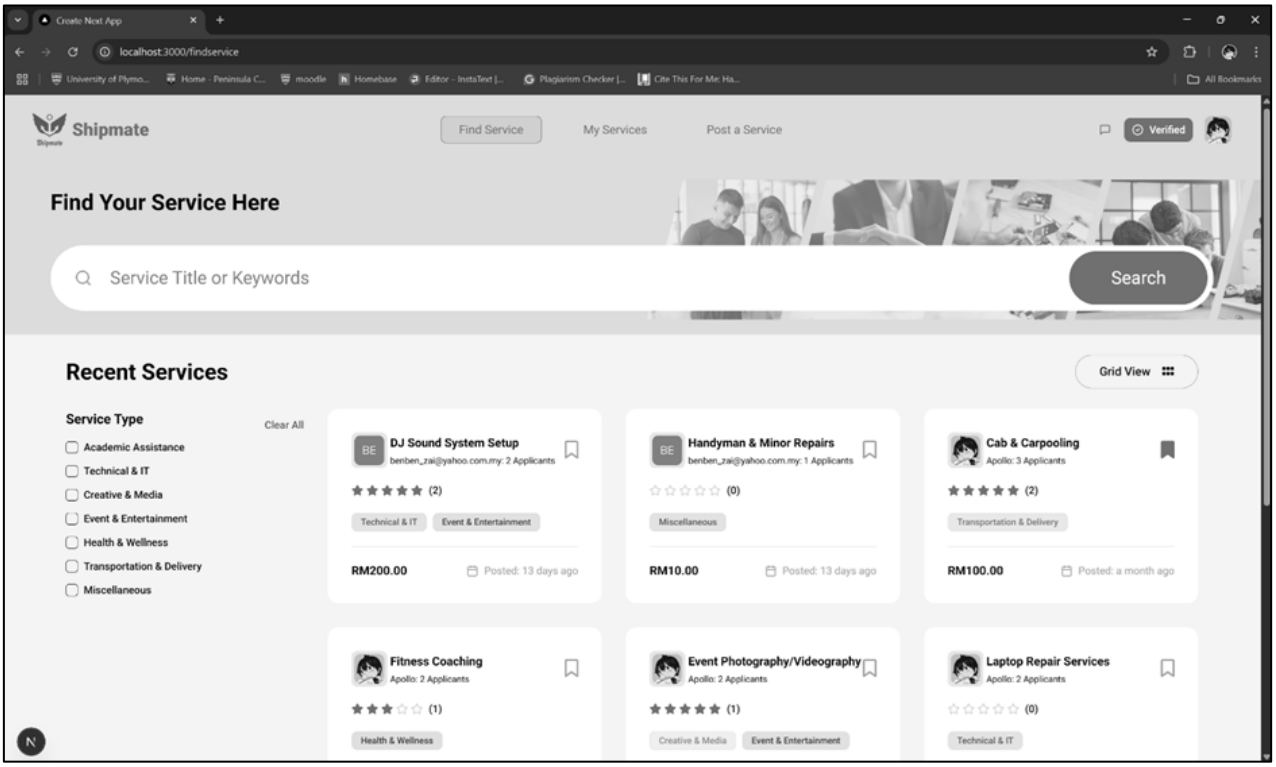

Figure 5 Screenshot of the system

The last objective is to evaluate the platform's usability and effectiveness in streamlining peer-to-peer service exchanges, ensuring it meets user needs and improves service accessibility. Both manual and automated testing were conducted to assess system reliability. Manual testing simulated real user behaviours to validate features like access control, service interaction, messaging, verification, and rating from both authorized and unauthorized user perspectives. Automated unit tests were performed on key backend controllers (Service Controller and Verification Controller) to confirm the accuracy of fundamental functions. All unit tests successfully passed.

4. DISCUSSION

This paper presents the development of Shipmate, a peer-to-peer student service system designed for The Ship Campus community, enabling students to offer, browse, and apply for various campus-related services. Key features include secure login via Auth0, real-student verification, service posting and application workflows, a review and rating system, and a messaging feature to facilitate user communication. Built using modern full-stack technologies, Next.js, for the frontend, Node.js and Express for the backend, and MongoDB for data storage, the system ensures role-based access control, allowing only verified students to post services. Comprehensive manual and unit testing were conducted across different user roles to validate functional accuracy and access restrictions. Overall, Shipmate demonstrates how a dedicated digital platform can support skill-sharing, promote student collaboration, and enhance self-sufficiency within a campus environment.

Despites its potential benefits, the Shipmate system has several limitations such as unofficial verification of users, lack of features for financial transactions, no native mobile application, limited resources and scalability, non-commercial and limited-service offerings, limits on market reach and audience, potential security and privacy risks and time and resource constraints.

Although Shipmate successfully delivers its core functionalities, several enhancements are planned to improve its effectiveness and user experience. These include implementing real-time messaging using technologies like WebSockets or Socket.IO, introducing AI-based service recommendations tailored to user behaviour and interests, and developing a notification system for timely alerts on applications, messages, status changes, and reviews. Further improvements involve integrating with the official school database for advanced student verification, creating an admin dashboard for better platform oversight, and adding moderation tools that allow users to report inappropriate content or behaviour, ultimately fostering a safer and more reliable environment.

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Smart E-Commerce Platform for Plastic Household Products and Vendor Supplies

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ABSTRACT

In 2018, WE CARE YOU Sdn. Bhd. was established with the goal of providing Malaysian customers with high-quality household products at a reasonable price. WE CARE YOU is an e-commerce, physical retail, and wholesale company that specializes in providing clients with necessary household supplies via a variety of channels. In order to adapt to the evolving demands of contemporary consumers, the company started out as an online retailer but soon expanded to offer both physical and online retail services. The business nature of WE CARE YOU is a household goods company that specializes in the retail and distribution of basic household necessities. The organization caters to a range of clientele, including businesses in need of solutions for bulk purchases and individual customers looking for ease in their buying. WE CARE YOU blends the convenience of online shopping with the individualized attention of physical stores by continuing to have a significant online presence on sites like Shopee and Lazada. This project implements Augmented reality in the e-commerce site. WE CARE YOU offers a curated range of essential household items, including cookware, cleaning supplies, and storage solutions which are selected for their quality, affordability, and durability. Serving both individual customers and businesses requiring bulk purchases, the company's mission is to enhance daily living by making household shopping more accessible and convenient. Its vision is to be recognized as Malaysia's go-to household brand, known for dependability, value, and outstanding customer service.

Keywords: E-commerce; Augmented Reality; Digital Business Management

1. INTRODUCTION

In Malaysia, traditional household product businesses face limitations in digital presence and operational efficiency (Reserve, 2024). WE CARE YOU Sdn. Bhd. aims to revolutionize this sector by providing high-quality household products through physical, wholesale, and online channels. Customers spend excessive time searching and comparing products. Inadequate product representation causes purchase hesitation. Additionally, businesses using generic platforms struggle to project a unique brand identity. This project applies theories in e-commerce personalization, augmented reality (AR) assisted shopping, and intelligent inventory systems to improve the consumer decision-making process and optimize inventory management. The hypothesis is that a smart e-commerce system integrating AR, inventory forecasting, and personalized recommendations can reduce user effort, improve decision confidence, and boost vendor efficiency. The research model comprises six key components: Product Recommendation, AR Shopping, Wholesale Management, Inventory Forecasting, Hawker Area Segmentation, and Seamless Reordering.

2. METHODOLOGY

The research adopts a design science methodology using Agile SDLC for iterative system development. No physical sampling is needed as this is a system-based implementation. Data was collected through usability testing and system functionality verification across login, recommendation, AR, cart, reorder, and checkout features. The main instruments used were HTML/CSS/JavaScript for frontend, Node.js and MongoDB for backend, and Teachable Machine for AR model training. Statistical analysis was not applied quantitatively but evaluated qualitatively through system behavior and task success during testing.

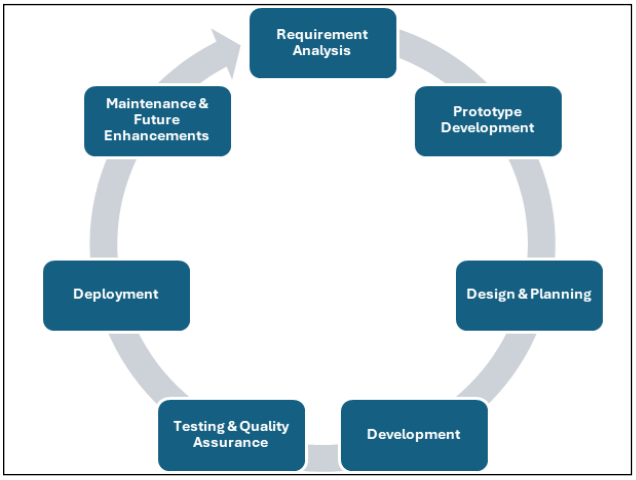

Figure 1 Software Development Life Cycle (SDLC)

3. ANALYSIS AND RESULTS

The results show high functionality across the six major features. Figure 2 shows that display of random product recommendations. Next, Figure 3 represents the interface for wholesale seller and products. Figure 4 implements AR recognition, and displaying matching product data in real-time. AR helped users quickly find products by scanning real objects. Figure 5 provide the insight on AR results after searching for specified product. Figure 6 portrays reorder functionality to ease the customers repeat orders without hassle. Figure 7 shows the display of intelligent inventory and management forecasting. Forecasting gave sellers insight on low stock trends and manage their stocks in an efficient manner. Figure 8 consists of "Exclusive Hawker" section which enables easy access to bulk and hawker-focused products. The features worked as expected across multiple test cases and were confirmed in usability testing logs.

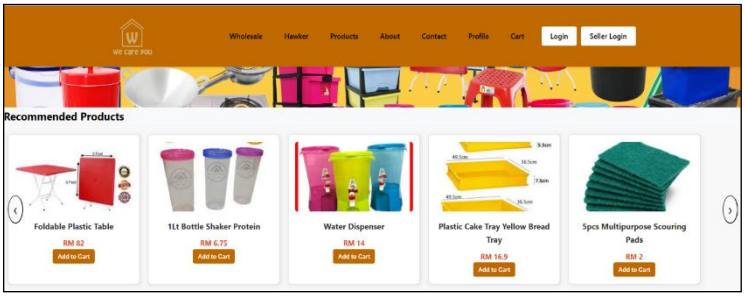

Figure 2 Display of Random Product Recommendations

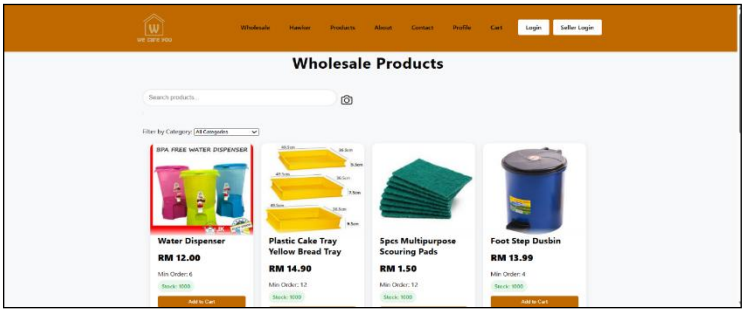

Figure 3 Wholesale Interface

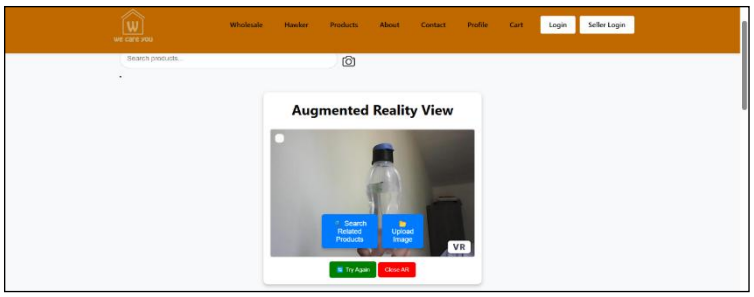

Figure 4 Augmented Reality

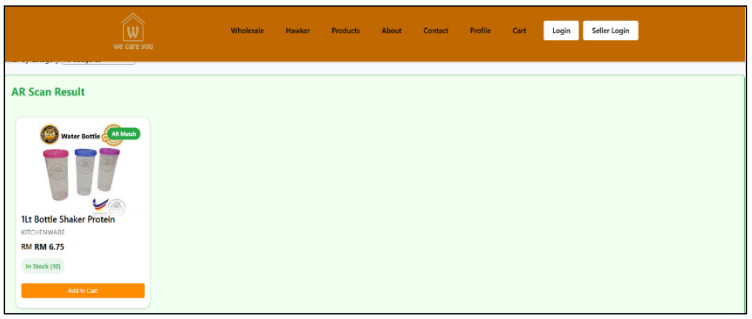

Figure 5 Augmented Reality

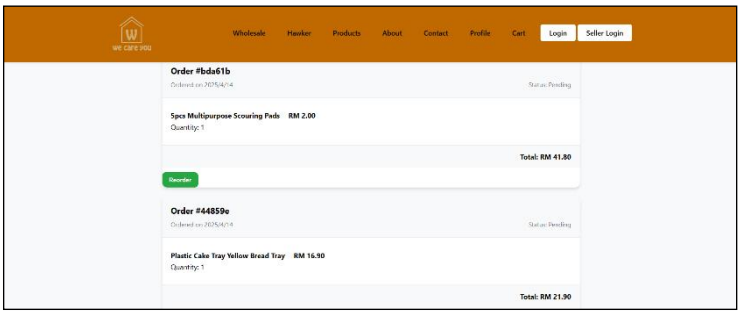

Figure 6 Reorder Functionality

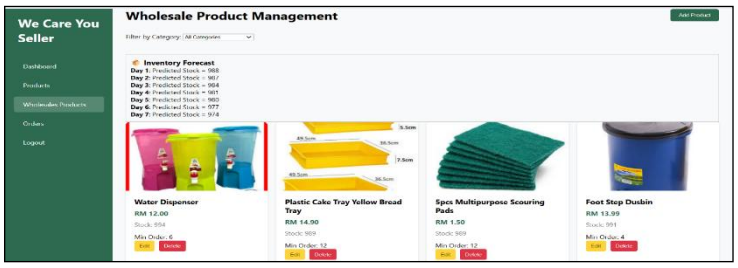

Figure 7 Display of Intelligent Inventory Forecasting and Management

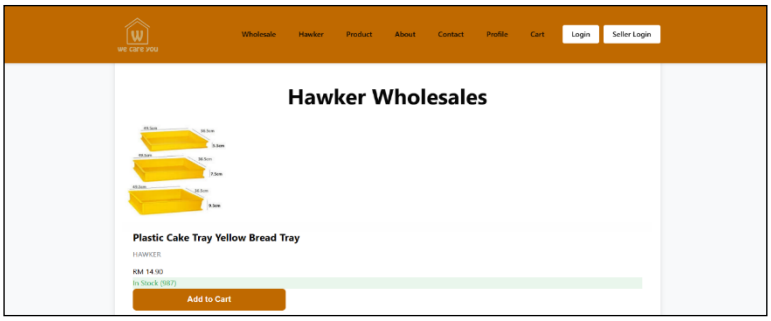

Figure 8 Hawker Wholesale Interface

4. DISCUSSION

The findings indicate that the integration of Augmented Reality (AR), product recommendations, and inventory forecasting features significantly enhances the user experience in e-commerce (ArtLabs, 2023). The AR function improved visual interaction by enabling users to identify products through image recognition, aligning with past findings by Nitika et al. (2022), who emphasized the value of AR in bridging physical and digital shopping. Additionally, the seamless reordering and forecasting features offered practical solutions for returning customers and sellers, promoting efficient inventory planning. Theoretically, this project supports the application of digital transformation and smart commerce frameworks. Practically, the platform addresses real market needs by simplifying the customer journey and offering specialized functions for hawkers and wholesale buyers.

However, limitations were identified. The AR model relies on Teachable Machine, which may not scale well for extensive product datasets or deliver accurate results under poor lighting. The inventory forecasting is based on simulated patterns and does not reflect real-time sales behavior, limiting its reliability. Future research should focus on integrating more advanced AR engines (e.g., ARCore), enhancing recommendation personalization using user behavior data, and applying real-time predictive analytics for inventory. Development of a vendor management dashboard and mobile optimization is also recommended for broader market adoption.

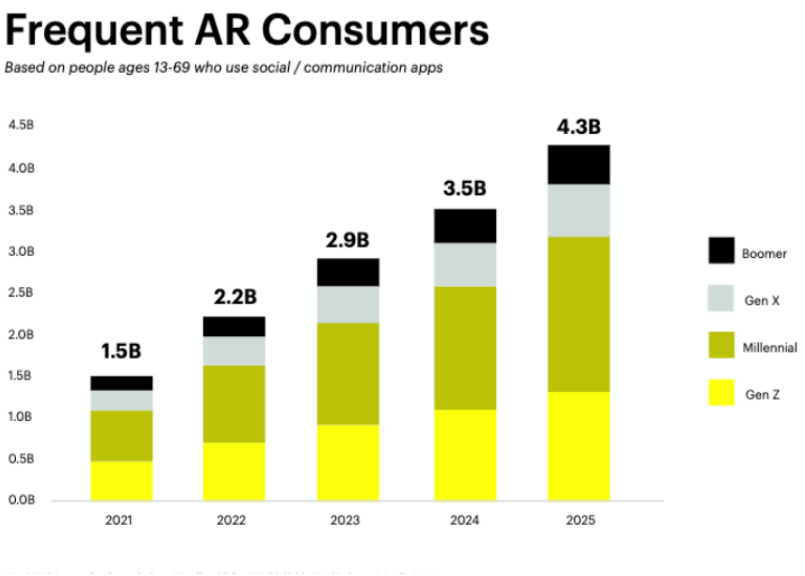

Figure 9 Frequent AR Consumers

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Filpal Nexus: A USB Management and Whitelisting Security System

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ABSTRACT

In collaboration with Filpal (M) Sdn Bhd, this project introduces Filpal Nexus, a USB whitelisting application that aims to strengthen endpoint security by safeguarding against threats such as unauthorized access, malware propagation, and data breaches. Developed using C# and C#.NET, the system uses a Device Unique ID for unique device identification, enabling a robust security mechanism that balances protection with user accessibility. Key features include real-time monitoring, a user-friendly Windows Forms interface, and an administrative panel to manage whitelisting policies, generate reports, and track events within the Windows environment. The project employs Windows Management Instrumentation (WMI) for real-time detection and leverages an SQLite database for device event logging. It follows an agile development methodology to iteratively refine the implementation while meeting security and usability goals. Extensive testing demonstrates its effectiveness in blocking unauthorized devices while supporting ease of use. With significant implications for corporate, educational, and governmental cybersecurity, Filpal Nexus provides a viable solution to address the persistent security challenges posed by USB devices.

Keywords: USB Whitelisting; Cybersecurity; Endpoint Security; USB Threat Prevention; Windows Management

1. INTRODUCTION

USB devices are convenient but have become major vectors for malware propagation, data exfiltration, and unauthorized system access. Existing measures like antivirus software and firewalls often fall short in preventing USB-based attacks. USB whitelisting, a security mechanism that restricts system access to authorized USB devices, offers an additional protective layer. Organizations face increasing risks due to the lack of robust, user-friendly USB security tools, particularly those tailored for Windows environments. Existing solutions are often costly, complex, or inefficient. By uniquely identifying USB devices via their Device Unique ID, unauthorized connections can be securely blocked at the operating system level. This research hypothesizes that Filpal Nexus can enhance USB management and endpoint security while maintaining user-friendly operation.

2. METHODOLOGY

A flexible and modern development style is used to create the Filpal Nexus system which is known as the Agile approach. Instead of building the entire system all at once, we broke the project down into smaller, manageable cycles called "sprints." Each sprint focused on developing and refining a specific feature, such as detecting USB devices, creating the whitelist, or logging activity. This allowed us to build, test, and improve the system step-by-step, ensuring each component worked perfectly before moving on to the next.

In order to ensure the system remains robust and reliable, a wide variety of USB devices was used to test the system. The testing was not limited to standard flash drives, hence various types of peripherals and Human Interface Devices (like keyboards and mice) were also tested to see how the system would react. This comprehensive testing ensured that our system could handle the diverse range of devices found in a real-world environment.

The system was designed to be a vigilant watchdog for all USB activity. To achieve this, it uses a built-in Windows feature called Windows Management Instrumentation (WMI) to monitor all USB ports in real-time. The moment a device is plugged in or removed, the system knows.

All of this activity, including details about the device and the action taken (whether it was approved or blocked), is recorded in a secure SQLite database. Think of this as a detailed digital logbook that keeps a permanent record of every USB event, which is crucial for analyzing security and performance.

The research instruments utilized in this study consist of three main components. The WMI detection triggers function as the system monitoring mechanism which continuously observing all USB connection events. Next, the SQLite logging database serves as a secure "logbook" where all device activity is recorded for later analysis and auditing. Lastly, the Windows Driver Management integration is utilized to act as the "enforcer," applying the security rules and policies you set, such as blocking or allowing specific devices.

Upon the completion of the development phase, it was paramount to validate that the Filpal Nexus system was not only secure in its function but also efficient in its operation. A security tool should protect without being a burden on the system it secures. Therefore, we conducted a rigorous analysis of several key performance indicators:

System Responsiveness and Detection Latency. We meticulously measured the time elapsed between the physical connection of a USB device and its recognition by the system. A swift detection time is critical, as it directly correlates to how quickly a potential threat can be neutralized. Our goal was to ensure this process was nearly instantaneous.

Resource Overhead and System Footprint. An effective security application must integrate seamlessly into the user's workflow without causing noticeable slowdowns. We continuously monitored the system's consumption of CPU and memory resources during idle states and active scanning. This ensured the application remained lightweight and did not hinder computer performance or user productivity.

Authentication Accuracy and Reliability. The core of our evaluation centered on the system's precision in distinguishing between authorized and unauthorized devices. We tested for two outcomes: the system's ability to reliably block all unauthorized devices without exception, and its proficiency in correctly identifying and granting access to whitelisted devices without error.

The culmination of these performance metrics confirmed that the Filpal Nexus system operates as a highly effective and unobtrusive security solution. Our analysis validates that it provides robust protection against unauthorized USB devices while maintaining a minimal performance footprint, thereby ensuring a secure and efficient user experience.

3. ANALYSIS AND RESULTS

After subjecting the Filpal Nexus system to a series of rigorous tests, the results confirmed its effectiveness and efficiency as a USB security solution. The system performed exceptionally well, meeting and often exceeding our initial design goals.

Our analysis revealed that Filpal Nexus is both highly accurate and responsive. In our tests, it successfully identified and granted access to all authorized devices while consistently blocking any device that was not on the approved whitelist. This 100% accuracy in device matching is critical for ensuring a secure environment.

Furthermore, the system's performance was impressive. We measured the detection latency—the time it takes for the system to recognize a device once it's plugged in—and found it to be consistently under two seconds in typical operating conditions. Even when the computer was under heavy use, the system's responsiveness remained strong, with only a negligible increase in detection time. This ensures that security does not come at the cost of performance.

Finally, we found that the system's resource overhead was minimal. It runs quietly in the background without consuming significant processing power or memory, meaning users will not experience any slowdowns or disruptions in their daily work.

Table 1 provides a consolidated view of the performance metrics for different types of USB devices tested. These results highlight the system's consistent accuracy and speed across various hardware.

Table 1 Summary of Tests

Test Parameter	USB Storage Devices (e.g., Flash Drives)	Human Interface Devices (HID) (e.g., Keyboards, Mice)	Overall Performance
Test Cases Executed	10	5	15 Total
Device Matching Accuracy	100%	100%	100% Accuracy
Average Detection Time	~2.0 seconds	~2.5 seconds	~2.2 seconds
System Resource Impact	Minimal	Minimal	Negligible

As the data shows on Table 1, whether dealing with a common USB flash drive or a peripheral like a keyboard, Filpal Nexus demonstrated perfect accuracy and swift detection, solidifying its reliability as a robust and efficient security tool.

4. DISCUSSION

The results confirm that Filpal Nexus effectively mitigates USB-related security threats while maintaining usability. Its reliance on WMI ensures seamless device monitoring with robust hardware-level detection.

This project advances the field of USB endpoint security by proposing an accessible yet robust whitelisting solution. Practical applications extend to corporate IT environments, educational institutions, and government agencies concerned with USB-based threats.

Compatibility testing was limited to Windows-based systems. Cross-platform applicability needs exploration. Dependency on external tools (e.g., nuget packages) may introduce challenges in future system upgrades.

Future iterations should focus on expanding the system for use in cross-platform environments, integrating machine learning for dynamic threat detection and enhancing user interfaces with visual tracking and reporting dashboards.

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