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Tackling Tomorrow's Challenges with NFC Mobile Payment in Public Transport System

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Abstract
This study delves into Near Field Communication (NFC) mobile payment for Kuala Lumpur's public transit, focusing on public Awareness and attitudes. Through an online survey, 333 completed responses were gathered from Kuala Lumpur residents. Statistical analysis, including Cronbach's Alpha Reliability Test, Spearman's Correlation Coefficient Analysis, Descriptive Analysis, and Multiple Linear Regression Analysis revealed significant positive correlations between Awareness, Attitude, and NFC adoption for public transportation. Results highlight a strong association between Attitude and NFC adoption inclination, indicating widespread Awareness and favorability. These insights are crucial for policymakers and stakeholders implementing NFC technology in Kuala Lumpur's public transport system.

Keywords: Mobile; Payment; Awareness; Public Transport

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1.0 Introduction

Compared to traditional payment methods, mobile payments offer enhanced convenience and speed and eliminate the need for cash (Obando et al., 2024). Since 1980, intelligent public transportation systems have evolved through multiple stages of development through cooperative initiatives and public-private partnerships, culminating in what is currently known as the CITS (Cooperative et al.) (Visan et al., 2022). Despite this growth, a significant gap exists in discussions surrounding mobile payment usage within public transportation, representing a notable research void. Failing to comprehensively understand the factors influencing usage intention among public transport users may result in heightened dissatisfaction. Hence, the primary objective of this study is to i) determine the public's Awareness towards NFC mobile payment adoption for public transportation and ii) to examine the construct of Attitude of users toward NFC mobile payment adoption for public transportation in Kuala Lumpur, Malaysia.

1.1 Problem Statement

The rapid evolution of technology, coupled with the onset of Industry Revolution 4.0 (IR 4.0), has significantly transformed various aspects of society, particularly in the domain of payments, which can now be effortlessly executed with a single click. With

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smartphones being omnipresent for both personal and business purposes, they have emerged as the preferred platform for managing mobile wallets, leading to a decreased reliance on physical cash (Hinga et al., 2024). The COVID-19 pandemic further expedited the transition towards cashless transactions through electronic and digital channels, resulting in a substantial surge in e-commerce (Ardi et al., 2024). As measures like physical distancing and movement restrictions became commonplace, the virtual and contactless attributes of e-wallets positioned them as the favoured payment method (Ardi et al., 2024). Consequently, the consumption of emerging digital services witnessed a significant upsurge during the pandemic, likely alleviating consumer hesitations regarding online transactions (Alam et al., 2021).

Despite advancements like Near Field Communication (NFC), which simplifies payments by allowing transactions when the card and processing terminal are nearby, previous NFC implementations have demonstrated limited adoption (Bojjagani et al., 2023). Research indicates a need for more comprehension and high consumer adoption rates, highlighting the necessity for broader exposure to NFC technology (Krauss et al., 2022).

NFC-enabled devices offer distinct advantages in the transportation sector by eliminating the need for additional electronic tokens and facilitating seamless system updates (Chen & Chen,2022). Implementing contactless ticketing and payment options has bolstered passenger satisfaction, increased throughput, and reduced boarding times, addressing concerns associated with paper tickets while enhancing ecological sustainability (Dreyer et al.,2021). They have also summarized that, unlike contactless intelligent cards, NFC-enabled phones empower users to manage multiple tickets and payment cards digitally, thereby streamlining the transit experience.

With the streamlined payment processes observed in transit systems of cities like London, San Francisco, and Frankfurt, Malaysia's adoption of NFC systems still needs to be improved (Fauzan Aris et al., 2022). Despite the widespread prevalence of mobile technology in Malaysia, particularly with a high percentage of mobile users, mobile payments, especially NFC-enabled transactions, are still in their early stages of development. Not only that, but they have also highlighted that despite the potential benefits documented, the penetration rate is reported to be relatively low and slow in the context of developing countries. This is mainly due to consumers' different behaviours, perceptions and values. Fig 1 indicates the NFC payment trend in Malaysia with a majority of "No" experience, although with some availability of NFC in their smartphone. This has created a gap for this research to fill by looking at their Awareness and Attitude towards NFC payment in public transport.

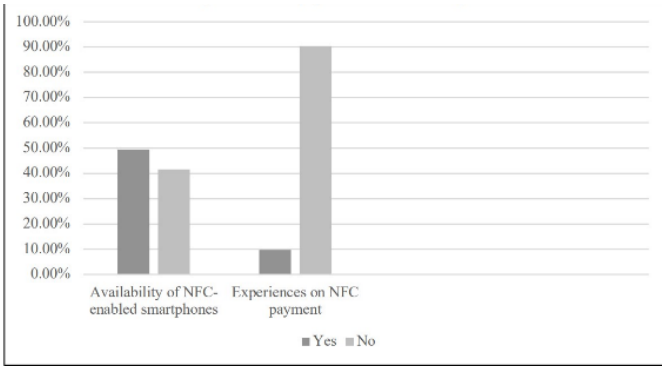

Fig 1: NFC-payment trends in Malaysia in 2021
Source: Alam et al (2021)

Today, more than 40 NFC payment types exist in Malaysia, implying that the technology is growing (Alam et al., 2021). Still, the NFC mobile payment system has yet to gain attraction in Malaysia, emphasizing the need for further exploration, especially when most Malaysians have no experience with NFC, as shown in Fig 1.

2.0 Review of Literature

2.1 NFC Payment

In Malaysia, the spread of mobile payment has gradually increased, with many banking institutions collaborating with technological companies and reengineering their card systems and applications to enable NFC payment transactions (Chew et al., 2020). The development of NFC is often limited to the proximity between two devices with a maximum range of 20 cm but typically 4 cm (Nikitina et al.,2024). Figure 1 shows the possibility of NFC technology usage to pay for the public transport fare.

Fig. 1: Process flow of NFC mobile payment on public transport.
(Source: Luqman,2023)

Today, countries like the United Kingdom, China, and Singapore have adopted and implemented NFC mobile payment on public transportation. Passengers can use their mobile devices and tap at the reader in the bus and train stations before boarding. They do not need to dig and search for the cards or tickets inside their wallet or bag. The figure above shows an example of process flow when using NFC mobile payment on public transport. From the passengers' perspective, they can select a preferred method, such as bank cards and electronic wallets (e-wallets) from different applications, to pay for their fares.

However, the payment method for public transportation in Malaysia, especially in KL, still uses cash to purchase tickets, concession cards, and travel passes. The adoption of using NFC mobile payment on public transport in Kuala Lumpur, Malaysia, still needs to be introduced to the public, leaving a massive study gap.

2.2 Theory

The Technology Acceptance Model (TAM), created by Davis in 1989, explains the purposeful action of users when embracing new technology. This research has been used to understand the Intention to use the NFC mobile payment for public transport. The most popular model for predicting technology adoption behaviour is the TAM. Most earlier research focuses on factors that influence the adoption of mobile payments, with the TAM frequently regarded as the theoretical foundation (Fauzan Aris et al., 2022). Therefore, the theory was selected to underpin the theoretical framework in this study as the studies will examine how people employ newly acquired information technology.

2.3 Awareness

Dayour et al. (2020) defined the term "awareness" (AW) as "the degree to which an individual becomes knowledgeable about a technology in terms of its functions, benefits, limits and security-related issues". Thus, if people do not adopt mobile payment technology, they may be unaware of its availability and added value (Aljawder & Abdulrazzaq, 2019).

A study by Kawshalya (2020) highlighted that Awareness is a significant factor in the UK's adoption of NFC payments. This was then supported by a survey by Balakrishnan and Shuib (2021), who discovered that lack of Awareness has a significant negative relationship with perceived readiness for cashless. It indicates that people's perceived readiness to go cashless can be influenced by their poor Awareness of digital payment services.

Overall, evidence indicates a relationship between Awareness and the Intention to use new technology such as NFC mobile payment. Besides that, Awareness impacts TAM as it influences the Intention to use technology (Billanes & Enevoldsen, 2021). Following this argument, this study posits that:

H_1: There is a positive relationship between Awareness (AW) and the Intention to use NFC mobile payment on public transportation.

2.4 Attitude

Aside from Awareness, the construct of Attitude also determines NFC usage. Attitude (ATT) encompasses human behaviour's cognitive, emotional, and behavioural components (Tsai et al.,2010). They have also suggested a similar connection for new payment systems, predicting that positive attitudes will lower resistance to adopting mobile payment systems. This was backed up by (Schierz et al., 2010), who have indicated the detailed elements influencing consumer acceptability of mobile payment services and reasons for underutilization despite mobile technology's prevalence. Their model, building on the Technology Acceptance Model (TAM), explains 84% of attitudes toward usage and 85% of Intention to use mobile payment, indicating its significance. Multiple studies, including Fauzan Aris et al. (2022), support the link between Attitude and behavioural Intention in mobile payments, with significant correlations observed from a study conducted by Nguyen, 2024).

Overall, there is evidence of a relationship between Attitude and Intention to use new technology like NFC mobile payment. Additionally, the Attitude toward technology use influences the intention toward new systems or technologies in TAM (Warganegara & Hendijani, 2022), forming the basis for the second hypothesis.

H_2: A positive relationship exists between Attitude (ATT) and the Intention to use NFC mobile payment on public transportation.

2.5 Conceptual Framework

The independent variables in this research have two influencing factors: Awareness and Attitude. The dependent variable is the intention to use NFC mobile payment for public transportation. The two independent variables are to be affected by the dependent variables. The conceptual framework is shown in the figure below.

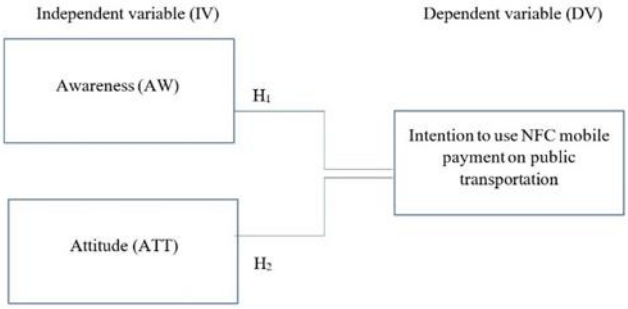

Fig 2: Conceptual Framework

The Technology Acceptance Model (TAM) has been applied to explain the independent variables of using NFC mobile payment on public transportation. Two variables have been adopted from this theory: awareness and Attitude. Two hypotheses are developed according to these variables, and a conceptual framework is developed.

3.0 Methodology

Following Sham et al.'s (2023) recommendation, this study adopts a quantitative research approach, gathering data through online questionnaires from Kuala Lumpur residents. This study is restricted to respondents residing and working solely within the urban area of Kuala Lumpur. Zikmund (2010) supports this decision, highlighting the method's suitability for numerical measurement and analysis, facilitating generalizations. Careful attention was paid to sample selection criteria, ensuring participants were within the age range of 18 to 60 and resided in Kuala Lumpur. Random sampling, as suggested by Mahajan (2020), was employed to enhance accuracy, reliability, and validity, with Sham et al. (2024) confirming its potential representativeness. The choice of Kuala Lumpur was informed by its well-developed public transportation system (Fauzan Aris et al., 2022). Using Krejcie and Morgan's (1970) table, a target sample size of 384 was determined, with data analysis focusing on descriptive and inferential methods to test hypotheses (Hayes, 2022). Ultimately, the study received 333 responses, yielding a response rate of 96%, though 51 responses were discarded due to incomplete information.

4.0 Findings

The study begins by looking at how often people use public transportation. Around half of the 170 people surveyed(51.1%) are aware of NFC mobile payment, which lets you pay with your phone. The rest (48.9%) have not heard of it. This higher Awareness might be because NFC technology has been around for a while, even in Malaysia. When it comes to using public transport, most people (30.6%) use it every day. The next biggest group (21.3%) has yet to use it. Some use it weekly (20.4%), monthly (14.4%), or every few months (13.2%). Nearly 80% of respondents have used public transport before, but about 21% have yet to. As for NFC mobile payment, most people (70.3%) have yet to use it. A small percentage use it weekly (9.3%), daily (9%), or monthly (6.6%). Only a few use it every few months (4.8%). This highlights that while awareness of NFC exists, its adoption remains limited, potentially due to restricted phone compatibility. For example, in Malaysia, Apple Pay's recent launch is exclusive to Apple devices, with limited acceptance among banks and stores. Previously, Samsung Pay enjoyed broader usage tied to the study aims to gauge public awareness of NFC mobile payment for public transportation adoption.

Table 1: Descriptive Analysis of the Public Transport Users

Description	Scale	*Frequency*	*Per cent*
Familiarity with NFC mobile payment	Yes	170	51.1
	No	163	48.9
Public Transport Usage	Never	71	21.3
	Daily	102	30.6
	Weekly	68	20.4
	Monthly	48	14.4
	Every 2 – 4 months	44	13.2
Frequency of using NFC mobile payment	Never	234	70.3
	Daily	30	9.0
	Weekly	31	9.3
	Monthly	22	6.6
	Every 2 – 4 months	16	4.8

Table 2: Spearman's Rho Test on the Relationship between Independent Variables and Dependent Variable

		Awareness	Attitude	Intention to use NFC
Spearman's Rho	Awareness	1.000		
	Attitude	.559**	1.000	
	Intention to use NFC mobile payment on public transportation	.620**	.828**	1.000

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

According to Yan et al. (2019), authors explained that ρ equal to 0 to 0.19 (0≤ ρ ≤ 0.19) indicates a fragile relationship and when ρ equals 0.8 to 1 (0.8 ≤ ρ ≤ 1) indicates a solid relationship. Besides that, when ρ equals 0.2 to 0.29 (0.2 ≤ ρ ≤ 0.39), it indicates a weak relationship; when ρ equals 0.4 to 0.59 (0.3 ≤ ρ ≤ 0.59), it means a moderate relationship; when ρ equals to 0.6 to 0.79 (0.6 ≤ ρ ≤ 0.79), it denotes strong relationship.

Multiple linear regression (MLR) analysis estimates the relationship between the variables that correlate. It helps to determine the strength of the impact of each independent variable on the dependent variable and explore the effect of the changes of independent variables on the dependent variable. It also helps to project the trend or future values for the point estimates.

Table 3: Modal Summary in Regression Analysis

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.862[a]	.743	.742	.409

a. Predictors: (Constant), Awareness, Attitude

From Table 3, we can see the values of R and R^2. The adjusted R^2 of the model tells us how much of the total variation lies between the Dependent variable (Intention to use NFC mobile payment on public transportation) and the Independent variables (Awareness and Attitude). The result of this study shows that R^2 equals 0.743 with an adjusted R^2 of 0.742. This indicates that the linear regression explains 74.3% of the total variance in the dependent variable, and 74.2% can be explained by the independent variables. The R-value, which represents the simple correlation, is 0.862. This high value suggests a strong positive correlation between the independent and dependent variables.

Table 4: Coefficients in Regression Analysis

	Unstandardized Coefficients		Standardized		
Model	B	Std. Error	Coefficients Beta	t	Sig.
(Constant)	.584	.110		5.320	.000
Awareness	.158	.026	.206	6.070	.000
Attitude	.715	.033	.728	21.441	.000

a. Dependent Variable: Intention to use NFC mobile payment on public transportation

Multiple linear regression equation is shown as below:

$$\gamma = \alpha + \beta_1 X_1 + \beta_2 X_2 + \varepsilon$$

$$\gamma = \alpha + \beta_1 \text{ Awareness} + \beta_2 \text{ Attitude} + \varepsilon$$

$$\gamma = \alpha + 0.584 + 0.158 \text{ (Awareness)} + 0.715 \text{ (Attitude)} + \varepsilon$$

The multiple linear regression equation shown above, also known as the estimate equation, is used by researchers to make predictions. In this equation, γ represents the dependent variable, X represents independent variables, and Ɛ represents the error. From the results in the "β" column of Table 4, the beta for Awareness is 0.158, and the beta for Attitude is 0.715. This indicates that there is low Awareness but a high Attitude towards the Intention to use NFC mobile payment on public transportation. It suggests that Awareness about NFC technology needs to be increased. Therefore, it is crucial to promote this technology to the public, given their positive Attitude towards its use.

Table 5: Summary of Spearman's Rho Test for each Independent Variable with Dependent Variable

Independent Variables	Spearman's Correlation Value, ρ	Strength of Association
Awareness	.620	Strong
Attitude	.828	Very strong

Table 5 shows that Awareness has a positive and robust relationship with the dependent variable, Intention to use NFC mobile payment on public transportation (ρ = 0.620, 0.6 ≤ ρ ≤ 0.79). Furthermore, Attitude also has a positive and solid relationship with the dependent variable, the Intention to use NFC mobile payment on public transportation (ρ = 0.828, 0.8 ≤ ρ ≤ 1). Thus, it means the public is aware of and is considering using this NFC mobile payment on public transportation if available.

5.0 Discussions

This study aims to explore the receptiveness of urban commuters in Kuala Lumpur, Malaysia, towards utilizing NFC mobile payment for public transportation ticketing, with a specific focus on their Awareness and Attitude towards this technology. A questionnaire rooted in the Technology Acceptance Model (TAM) was devised to gather data and ascertain the primary influential factor between Awareness and Attitude. The analysis revealed that both Awareness and Attitude significantly impact the Intention to adopt NFC mobile payment for public transportation, echoing the conclusions drawn by Fauzan et al. (2023) and Davis's TAM theory (1989). Notably, among these factors, Attitude emerged as the most pivotal, signaling respondents' optimism regarding the integration of NFC technology into public transit systems. They perceive NFC as a promising and appealing innovation, foreseeing a positive user experience. Although Awareness also contributes to shaping the intention to adopt NFC mobile payment, its influence is overshadowed by that of Attitude. This indicates that while respondents possess some understanding of NFC technology, their positive attitudes towards it exert a stronger influence. These findings align with the prior research conducted by Mogaji and Nguyen (2024). Nonetheless, there persists a stated intention among respondents to embrace NFC technology once it becomes available. Consequently, the key implication of this study underscores the importance of enhancing public awareness regarding the introduction of NFC mobile payment technology. Such efforts are pivotal in realising the research objectives and ensuring the seamless adoption of NFC mobile payment within Kuala Lumpur's public transportation network.

6.0 Conclusion and Recommendation

In conclusion, this study aimed to assess public Awareness and attitudes towards adopting NFC mobile payment for public transportation in Kuala Lumpur, Malaysia, using two independent variables from the Technology Acceptance Model (TAM), Awareness and Attitude, which create a limitation of the research area which only focus on urban area and exclude rural population and other possible variables. Given Kuala Lumpur's importance as a transportation hub, the findings are significant for various stakeholders, including the public, researchers, government, banks, NFC service providers, and public transport operators. These findings will also significantly contribute to the insights of valuable guidance for understanding NFC adoption in public transportation and shaping future strategies. One of the recommendations to boost adoption is to reassess awareness and ramp up promotion of NFC usage. Future research should broaden the scope of the study by expanding the sample size to include respondents from diverse districts and states across Malaysia, encompassing both urban and rural populations. Additionally, upcoming studies should incorporate variables such as financial influence and internet coverage to achieve a comprehensive understanding.

Paper Contribution to Related Field of Study

This paper makes a substantial contribution to the field by examining the nuanced dynamics of Malaysian attitudes towards adopting Near Field Communication (NFC) technology within public transportation operations in urban areas. By concentrating on Malaysian urban settings, the study offers valuable insights into the perceptions and acceptance of this innovative technology in densely populated regions, where public transportation plays a crucial role in daily commuting. Through meticulous analysis and comprehensive data gathering, the paper offers precise insights into the readiness of Malaysian society to embrace NFC technology as a viable means of facilitating public transportation services. This includes examining factors, such as public Awareness and attitude, that influence the acceptance and adoption of NFC technology.

Ultimately, this research is a valuable resource for stakeholders in fostering technological innovation and improving public transportation efficiency in Malaysian urban areas. It paves the way for informed discussions, targeted interventions, and collaborative efforts aimed at harnessing the full potential of NFC technology to enhance mobility experiences and advance sustainable urban development agendas.

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