

Investigating QR mobile payment adoption in Malaysia: A diffusion of innovation perspective

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ABSTRACT

In recent years, a cashless society has become ubiquitous globally, considered an essential part of the digital payment system, especially in the Asia-Pacific region. However, a notable gap persists, as many Malaysians still use cash or other payment alternatives, posing a significant barrier to widespread adoption. Underpinned by diffusion of innovation (DOI) theory, this research aims to examine the impact of the DOI's elements on users' usage intention to adopt QR mobile payment services in Malaysia. This study employs a quantitative research design, with data gathered through a face-to-face survey of 102 respondents in the Klang Valley and analyzed using SmartPLS 4.0. It was found that QR mobile payment adoption is positively influenced by relative advantage and observability, while its adoption is negatively influenced by complexity. Meanwhile, the outcome is not influenced by compatibility and trialability. From a practical viewpoint, this study offers valuable insights for QR mobile payment providers, banks, government, policymakers, and any fintech companies by suggesting which elements can be controlled to boost the long-term use and adoption of QR mobile payments. From a theoretical standpoint, this study transcends beyond cognitive and functional criteria to understand the factors behind the adoption.

1. Introduction

Over the past decade, the cashless society has become ubiquitous globally. Out of many digital payments, 'quick-response' or QR-code mobile payment emerged as one of the most widely accepted digital transactions (Wong, 2025). It is considered an important method in the digital payment system, especially in the Asia-Pacific region. For example, QR-based applications like WeChat Pay and Alipay in

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China have developed into a consistent part of daily financial transactions, with more than 90 percent of users depending on QR-code payment.

Focusing on Malaysia, electronic payment activities grew from 3.6 billion in 2019 to 14.7 billion by 2024. In the same period, approximately 300,000 merchants adopted QR mobile payment, and the number rose to more than 2.6 million later (Wong, 2025). In December 2018, DuitNow QR was introduced as Malaysia's first interoperable QR payment standard by PayNet and Bank Negara Malaysia (Bank Negara Malaysia and Payments Network Malaysia (PayNet, 2018). Additionally, Kementerian Perdagangan Dalam Negeri dan Hal Ehwal Pengguna (KPDNHEP, 2022) reported that the Ministry of Domestic Trade and Cost of Living established the Retail Digitalisation Initiative (ReDI) in April 2021 to support this growth. This effort was undertaken to motivate retailers in Malaysia, especially small and rural retailers, to adopt digital payments. This payment method became a trend after the outbreak of Covid-19 as health and hygiene concerns encouraged merchants and users to use it more rapidly (Ahmad Ramli et al., 2023; Teoh et al., 2020). Even though the adoption shows favorable development, ensuring lasting usage relies primarily on users' usage intention. Hence, it is crucial to study the underlying factors influencing usage intention.

However, the quick development of QR mobile payment in Malaysia does not guarantee 100 percent adoption because many Malaysians are still using cash or other payment alternatives for payment activities (Hamzah et al., 2023; Wong, 2025). The gap occurs because of several factors including the digital divide, since there are people who may not have smartphones or lack internet access (Teoh et al., 2020), resistance to change and habitual traditional payment usage (Oliveira et al., 2016), risks linked to fraud or privacy (Dahlberg et al., 2015), and inconsistent merchant adoption, particularly among small businesses (Wong, 2025). Socioeconomic and demographic drivers also affect acceptance patterns (Chawla & Joshi, 2019). These circumstances show that infrastructure alone cannot guarantee extensive adoption.

Most previous studies have employed theories like the Technology Acceptance Model (TAM) or the Unified Theory of Acceptance and Use of Technology (UTAUT) in mobile payment adoption, highlighting elements such as security, usefulness, ease of use, and trust. These models may offer useful insights but do not focus on broader innovation elements that form user perceptions. Meanwhile, the Diffusion of Innovation (DOI) theory consists of additional components that may provide a more comprehensive understanding of adoption behavior (Rogers, 2003). Apparently, DOI theory application in the mobile payment domain remains insufficient, specifically in the context of QR mobile payment in Malaysia (Ahmad Ramli & Hamzah, 2021). Even though this theory has been employed in broader contexts such as mobile payment adoption among consumers (Shaw et al., 2022; Dash et al., 2023), its application is still absent in specific contexts like QR mobile payment and emerging markets, despite the theory's strengths. This gap must be addressed to gain a better understanding from multiple perspectives about the drivers affecting users' usage intention to use this digital system in Malaysia. Building on this foundation, this research aims to examine the impact of DOI theory elements on users' usage intention to adopt QR mobile payment services in Malaysia. Particularly, the objectives are: (1) to identify the individual effects of each DOI factor on Malaysians' usage intention to adopt QR mobile payments, and (2) to identify which factor has the strongest effect on usage intention.

The findings provide contributions in both aspects, practical and theoretical. From a practical viewpoint, this study offers useful insight for QR mobile payment providers, banks, the government, or policymakers, and fintech companies by suggesting which elements can be controlled to boost lasting usage and adoption of QR mobile payment. By identifying the most influential DOI element in the Malaysian context, this research can suggest strategies to promote the country's transformation toward a cashless economy, enhance user engagement, and support the design of more user centric QR payment services. Moreover, the research setting is the adoption of QR mobile payment, which continues to have a significant effect. The ubiquity of QR mobile payment nowadays helps many micro and small businesses, which leads to diffusion of the system to a wider user base (Hamzah & Ramli, 2023). Compared to other types of mobile payment, this system is more readily accessible to micro and small merchants, who represent the majority (98.5%) of the country's micro, small, and medium enterprises (MSME) establishments (Statista, 2023). In a small and traditional retail environment in which over-the-counter transactions are dominated by cash,

setting a new technology in motion requires these businesses to plan ahead. Theoretically, this study advances the application of DOI theory in the mobile payment domain by focusing on a more specific context, QR mobile payment adoption in Malaysia. Furthermore, it provides more information beyond traditional models such as TAM or UTAUT (Rogers, 2003; Chawla & Joshi, 2019).

2. Literature Review

2.1 Diffusion of innovation theory

Most commonly, innovation is considered as any new idea, process, product, technology, etc. As individuals perceive that, Rogers (2003) argues that each innovation has different attributes, which influence its diffusion in society. Established and developed by Rogers (2003), the Diffusion of Innovation (DOI) theory has a focus on the adoption of innovation. This theory involves the characteristics of innovation and how individuals perceive them. Five attributes were identified: (1) relative advantage, (2) compatibility, (3) complexity, (4) trialability, and (5) observability. These characteristics are considered as factors that shape the degree of innovation diffusion within a social system. Amini and Javid (2023) indicated in their study that three out of five attributes, namely compatibility, complexity, and relative advantage, were found to have the strongest impact on adoption decisions in previous research. Evidently, these factors offer a better framework than purely cognitive models because they incorporate both functional and social drivers of adoption.

The TAM model (Davis, 1989) and the UTAUT model (Venkatesh et al., 2003, 2012) emphasize mainly on elements like ease of use, social influence, and perceived usefulness. On the other hand, DOI theory combines innovation-specific characteristics that elucidate not just whether people adopt a technology but also why certain innovations diffuse faster than others (Hardgrave et al., 2003; Lee et al., 2011; Wang et al., 2012). Compared to the traditional models, DOI provides wider and more flexibility to conduct research on consumer technology adoption. The distinction of DOI theory makes it more relevant in the setting of QR mobile payment in Malaysia. This is because the adoption behavior is affected by drivers beyond the perception of efficiency and trust. QR mobile payment also involves the level of ease with which users can try it, the visibility of its benefits in daily payment transactions, and cultural norms (Min et al., 2018).

Additionally, Rogers (2003) proposed that diffusion is inherently a social process, wherein communication within a social system drives the spread of new technologies. The DOI theory is particularly appropriate for examining QR mobile payment adoption in Malaysia because it explicitly focuses on how innovation attributes and social system dynamics influence the spread and acceptance of new technologies (Chawla & Joshi, 2019). DOI's emphasis on communication channels and social influences also aligns with Malaysia's collective culture, where peer networks, interpersonal communication, and visible behavioural norms often drive consumer uptake of digital payment technologies; innovations that are perceived as compatible with local practices and easily observable within one's social circles tend to diffuse more rapidly (Ibrahim et al., 2019). Moreover, the theory's focus on reducing uncertainty through trialability and demonstrable benefits helps explain why QR mobile payments may be adopted more readily once consumers are exposed to tangible experiences and peer usage patterns (Rogers, 2003; Shaw et al., 2022).

Hence, DOI is considered to offer a better and more appropriate set of ideas for this research in both aspects, theoretical and contextual. It allows the examination of not only individual but also social dimensions of innovation acceptance. By examining DOI's five attributes in the Malaysian QR mobile payment setting, this research extends DOI theory into a new technological area as well as acknowledges a gap in comprehending the factors of usage intention in mobile payment adoption. As mentioned previously, Malaysia's rapid expansion of QR payment infrastructure alongside persistent uneven adoption (Wong, 2025), allows DOI to capture why certain users embrace QR payments while others remain reliant on cash or cards.

2.2 Relative advantage and usage intention

The accepted definition of relative advantage is the extent to which an innovation is regarded as better than the practices it replaces (Rogers & Shoemaker, 1983; Wang et al., 2018). Therefore, this study defines relative advantage as the degree to which QR mobile payment is viewed to be superior to other alternative payment methods. Among the attributes of Rogers' DOI theory, relative advantage is perceived as one of the strongest drivers of innovation adoption. Any innovations that offer noticeable advantages such as cost savings or improved quality tend to be accepted by users (Lin & Chen, 2012). Furthermore, this attribute was confirmed to have a positive impact on attitudes and behavioral intention across many studies, for example, in research on e-learning by Lee (2007) and Lee et al. (2011) or cloud computing by Oliveira et al. (2014). Consistent with Shih and Fang (2004), who suggested that relative advantage significantly influences the usage of Internet banking. Similar to Wang et al. (2019)'s study, it also has an effect on developers' acceptance of green building technologies. Collectively, it is suggested that users are more likely to choose new technologies when they perceive added value (relative advantage) compared to current options.

Referring to the context of the QR mobile payment system, relative advantage is also regarded as a crucial factor because people nowadays seriously consider QR-based digital payment options over cash, card-based transactions, or other alternatives. When an innovation provides better, quicker, more secure, and more convenient features than current methods, users are more likely to have stronger usage intention, which leads to adoption (Al-Rahmi et al., 2019). Apparently, Lee et al. (2011)'s study shows that relative advantage affects ease of use and perceived usefulness in digital platforms. Similarly, Liljamo et al. (2018) proposed that innovations viewed as superior alternatives significantly improve adoption attitudes. Applied to this study's setting, relative advantage may be present in features such as seamless cross-platform transactions, reduced reliance on other alternatives, and encouraged integration with government-backed initiatives like DuitNow QR. As previous studies stated, these perceived benefits are important factors of usage intention, making relative advantage crucial to study in this area.

In Malaysia, where cash and other payment alternatives are still widely present, the relative advantages of QR mobile payment such as convenience, easy access, safety, and speed may influence whether users continue to use the system in the long term. Consequently, these arguments underpin the following proposed hypothesis:

H₁: Relative advantage positively influences users' usage intention in adopting QR mobile payment in Malaysia.

2.3 Compatibility and usage intention

Compatibility is the extent to which an innovation aligns with users' current values, prior experiences, and current needs (Rogers & Shoemaker, 1983; Wang et al., 2018), hence it is very important in new technology adoption. Hence, this study views compatibility as the degree to which the QR mobile payment fits with the users' existing values, previous payment methods, and current needs. Users do not need extra effort to adjust and experience less disturbance to their habitual activities when they perceive a new innovation as compatible, which strengthens ease of use and perceived usefulness (Shiau et al., 2018). In Shiau et al. (2018)'s study of OpenStreetMap adoption, compatibility was indicated to have a positive impact on perceived usefulness, suggesting that alignment with previous practices helps wider adoption. This elucidates that compatibility in digital service adoption confirms the smooth integration of innovation with consumers' daily routines and expectations, therefore decreasing resistance and increasing the likelihood of adoption.

In the QR mobile payment setting, compatibility plays a pivotal role when users perceive this new digital payment method as aligning with their current financial behavior, lifestyle, and daily transactions. Prior research in technology acceptance like Wu and Wang (2005), Chang and Tung (2008), and more recent studies such as Alshurideh et al. (2023), Hoque and Sorwar (2022), and Marikyan et al. (2021) has agreed that compatibility has a positive influence on usage intention by guaranteeing consistency between innovation and users' needs. Furthermore, it is emphasized that the adoption level increases significantly when mobile technologies are consistent with users' values like convenience or integration with daily transactions (Wang et al., 2018; Shiau et al., 2018). Thus, compatibility in QR mobile payment may emerge in features like quick and easy integration with banking applications, combination with government-backed initiatives (e.g., DuitNow QR in Malaysia), and alignment with consumers' preference for speed and contactless transactions.

Collectively, any innovation that reduces disruption and integrates smoothly with consumers' current payment methods tends to be accepted and continuously employed. Based on these insights, this study hypothesizes:

H₂: Compatibility positively influences users' usage intention in adopting QR mobile payment in Malaysia.

2.4 Complexity and usage intention

Complexity can be defined as the extent to which an innovation is perceived as difficulty to comprehend and use (Rogers & Shoemaker, 1983). This study refers complexity is the degree where the users perceive difficulties in QR mobile payment system usage which influence their intention. Many studies persistently propose, high level of complexity led to low adoption of technology due to users' impression of difficulties, risk, extra efforts, or uncertainty (Lee et al., 2011; Alkhuzaie et al., 2025; Chen, 2023; Qalati et al., 2021; Ashrafi et al., 2021). Verily, is closely related to but conceptually different from ease of use in TAM model. Mardiputra et al. (2021), Hasan (2007) and Lee et al. (2011) proposed that higher complexity impacts ease of use and perceived usefulness, negatively. There is more previous research in emerging technologies have confirm about this, complexity can be considered as a major hindrance to acceptance due to consumers stumble with comprehending features, functions, and processes (Casino et al., 2019; Queiroz & Wamba, 2019).

In mobile payment acceptance, the presence of complexity especially intense in certain processes such as authentication, setup, or transactions, which may uninterest users to switch from traditional payment methods. If users think QR mobile payments involve too many steps, technical knowledge, or additional effort, their usage intention drops, adoption decreases. Additionally, advance infrastructure in Malaysia does not guarantee the mobile payment acceptance as many users still perceive QR payment as difficult to traditional methods (Wong, 2025). Empirical research further advocates this, indicating that when confusion or high cognitive load occurs in digital systems, users have tendency to refuse to use the platform (Shiau et al., 2018; Al-Rahmi et al., 2019). Lessen perceived complexity helps QR mobile payment to offer convenience, user-friendly, and smooth experiences in this system. Hence,

H₃: Complexity negatively influences users' usage intention in adopting QR mobile payment in Malaysia.

2.5 Trialability and usage intention

According to Rogers and Shoemaker (1983), trialability can be accepted as the degree to which can be experimented with on a limited bases before full acceptance. Trialability in this study is the level to which users believe the likelihood of experiencing QR mobile payment before make decision to adopt it or otherwise. Trialability has capability to diminish uncertainty by letting prospective users to experience and

assess an innovation's advantages directly. Lee (2007) and Lee et al. (2011) users' confidence and familiarity are positive when they are given chances to trial a system, which led to intention to adopt. In educational domain, trialability was also proven to significantly form learners' attitude towards MOOCs and their intention to employ them, proposing its wider relevance across digital innovations.

Trialability is specifically crucial in mobile payment setting because users may initially be uncertain to switch from current methods of payments. By providing free demonstration, trials or limited-time incentives, consumers can experience QR mobile payment usage in low-risk settings, which decreases users' hesitant. Recent findings in other technology area have confirmed that trialability through demonstrations encourage perceived ease of use and adoption (Yuen et al., 2020). Not just that, trialability in financial technologies offers users with experiential knowledge that create trust and encourage adoption (Al-Rahmi et al., 2019).

Hence, in the context of QR mobile payments in Malaysia, trialability may have the ability to lessen the gap between initial awareness and sustained to use. By diminishing entry barriers and providing hands-on experience, trialability can enhance user confidence, making it a significant factor of usage intention. Based on this reasoning, this study hypothesizes:

H₄: Trialability positively influences users' usage intention in adopting QR mobile payment in Malaysia.

2.6 Observability and usage intention

Observability can be accepted as the degree to which the advantages and outcome of an innovation are visible to others, thereby affecting its acceptance (Rogers, 2003). This study defines observability as the extent to which users can see the benefits and how QR mobile payment works which led to continuous intention to use. When the visibility of an innovation benefits is clear, it encourages judgement and discussion among prospective consumers which decreases uncertainty and increase trust. Recent studies have shown that observable features enhance perceived ease of use (PEOU), perceived usefulness (PU), and behavioral intention, as presented in study of e-bike adoption (Gumasing, 2025) or digital tools adoption (Rahim et al., 2024). Similarly, in mobile applications like Uber, features such as transparent fare estimates, driver details, and trip history increased user confidence and positively shaped adoption decisions by making the system's benefits more visible and credible (Park & Chen, 2007).

Observability plays important part in QR mobile payment because consumers commonly comprehend about this application through social influence and apparent use in social and commercial settings. For example, when users observe people make transaction using QR codes in any merchants, they become more mindful of its dependability which encourage the adoption. Previous research highlights that visibility of innovative financial technologies, particularly in social and public contexts, promote higher trust and boost adoption intentions (Yuen et al., 2020; Al-Rahmi et al., 2019). Considered as very relevant in Malaysia, where QR mobile payment were promoted via platform like DuitNow QR, led to high engagement in usage and highly observable in daily payment activities.

Therefore, observability is crucial in QR mobile payment adoption as it allows users to witness the tangible benefits before personally adopting the system. Especially when the advantages of speed, convenience, and security are publicly visible. Based on these reasoning, this study hypothesizes:

H₅: Observability positively influences users' usage intention in adopting QR mobile payment in Malaysia.

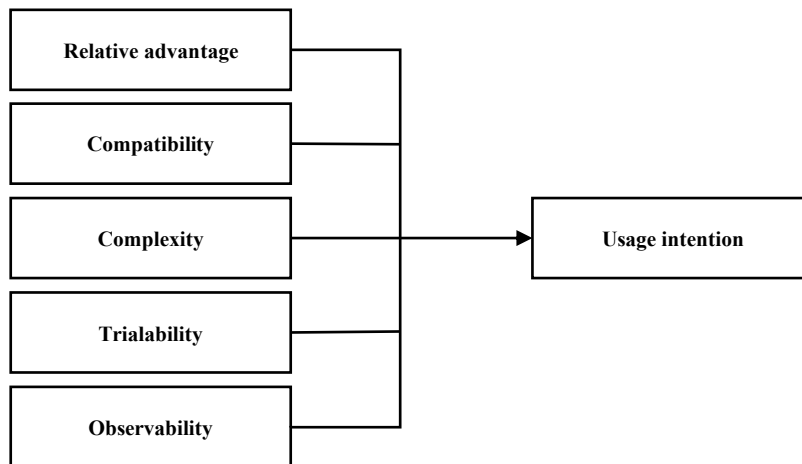


Figure 1. Research framework

3. Methodology

3.1 Samples and data collection procedures

Through the face-to-face survey method, respondents were selected based on purposive sampling across several higher education institutions in Klang Valley, Malaysia. Purposive sampling was employed to ensure that respondents possessed relevant experience and familiarity with QR mobile payment usage, which is essential for accurately examining usage intention and adoption-related constructs. In addition, higher education institutions were selected as the study context because they comprise a population that is generally more exposed to digital technologies, cashless payment systems, and frequent mobile payment usage, making them appropriate for investigating QR mobile payment adoption behavior. Individuals eligible to participate were consumers aged 18 years and above who possessed QR mobile payment applications on their smartphone. Respondents were screened to confirm they actively used QR mobile payments at terminal scanners. Central Klang Valley was selected due to its high population density and accessibility. The choice of this setting was also supported by the increasing adoption of QR-code-based mobile payment in Malaysia, influenced by government initiatives such as the e-Tunai program (Wong, 2019). These initiatives were assumed to have further encouraged the widespread use of QR-code mobile payments, making data collection more efficient. Out of the distributed questionnaires, only 102 responses that met the eligibility criteria were considered valid for analysis.

3.2 Measures

All the variables in this study were adopted from previous research to fit the QR mobile payment context. These include relative advantage (Kaur et al., 2020), compatibility (Kaur et al., 2020), complexity (Kasilingam, 2020) where items were reverse coded, trialability (Shaw et al., 2022), observability (Shaw et al., 2022), and usage intention (Venkatesh et al., 2012). To ensure clarity and content validity, two academic experts in technology marketing reviewed and refined the measurement items, removing any that were confusing, debatable, or suggestive. The latent constructs were then measured using a seven-point Likert scale, ranging from 1 (“Strongly disagree”) to 7 (“Strongly agree”), as it can capture subtle differences in user perceptions, aligns with prior DOI and adoption research, and allows stronger statistical analysis.

3.3 Analysis tools and method bias

In technology adoption research, structural equation modeling (SEM) is widely applied to test causal models and examine relationships between independent and dependent variables (Gefen et al., 2011). Since this study involves users' usage intention to adopt QR mobile payment in Malaysia, SEM provides a suitable method for testing these hypotheses simultaneously. The latest SmartPLS software was used to conduct the analysis. Partial least squares SEM (PLS-SEM) was chosen over covariance-based SEM (CB-SEM) for two main reasons: first, PLS-SEM is more effective in handling complex models that include multiple latent constructs and indicators (Chin et al., 2008); and second, it is better suited for explaining variance in behavioral intentions, which aligns with this study's focus on understanding users' adoption of QR mobile payments (Hair et al., 2017).

As the data were collected through self-reported survey responses, common method variance (CMV) was a potential concern (Podsakoff et al., 2003). To address this, both procedural and statistical remedies were applied. Procedurally, a pilot study and expert review were conducted to refine measurement items and reduce ambiguity, while participants were assured of anonymity to minimize social desirability bias. Statistically, Harman's one-factor test (Podsakoff & Organ, 1986) and the marker variable test (Lindell & Whitney, 2001) were employed. The Harman's one-factor test revealed that the first factor accounted for only 49.92% of the variance, below the recommended threshold, suggesting that CMV was not a major issue. The data were further analyzed using SmartPLS to compare the model's R^2 values with and without the marker variable. The results showed an increase of 0.004 (0.4%) in the R^2 value between the two models, which is relatively small and less than 10%. According to Fuller et al. (2016) and Podsakoff et al. (2003), this lack of difference indicates that common method bias is not a concern in this study.

4. Finding

4.1 Respondent' profiles

After screening, 102 valid responses were retained for analysis. The sample consisted mainly of females (71.6%), with males making up 28.4%. A large majority of respondents were between 18 and 23 years old (92.2%), reflecting a young user base. As the sample is heavily concentrated within a single age group, the findings may have limited generalizability to older populations. Most participants had completed high school or held a diploma (92.2%), while only a small number reported a bachelor's (3.9%) or postgraduate qualifications (3.9%). In terms of income, nearly all respondents earned below RM2000 per month (95.1%), with only a few reporting higher income levels. For QR mobile payment apps, the Bank Islam Go App was the most frequently used (52.9%), followed by MAE/Maybank2u (22.5%) and Touch 'n Go eWallet (13.7%), while usage of other apps such as CIMB Clicks/OCTO and Setel remained minimal. A detailed summary of these characteristics is presented in Table 1.

Table 1. Respondents' demographic profile

	Demographic Variable	n	%
Age	18–23 years old	94	92.2
	24–29 years old	3	3
	30–39 years old	5	4.9
Gender	Male	29	28.4
	Female	73	71.6
Education level	High School or Diploma	94	92.2
	Bachelor's Degree	4	3.9
	Post-Graduate Degree (Master/Ph.D)	4	3.9

Monthly income	<RM2000	97	95.1
	RM2001-RM9999	4	4
	RM10,000 & above	1	1
QR mobile payment App	Touch and Go eWallet	14	13.7
	MAE / Maybank2u	23	22.5
	CimbClicks / OCTO	8	7.8
	Setel	2	2
	Bank Islam Go App	54	52.9

4.2 Measurement model

Prior to the measurement model assessment, items for the complexity construct were reverse coded during the data preparation phase. This adjustment was necessary so that higher values represent lower perceived complexity. This ensured that all measurement scales followed a uniform direction during the model assessment.

The measurement model was assessed to ensure reliability and validity following the four common criteria: item reliability, construct reliability, convergent validity, and discriminant validity (Gefen et al., 2011). Since the constructs were modeled as reflective, individual item loadings were examined to determine item reliability. As shown in Table 2, most items had loadings above the recommended threshold of 0.70, confirming good item reliability. Construct reliability was assessed using composite reliability (CR), with all constructs scoring above 0.90 (ranging from 0.896 to 0.969), exceeding the minimum benchmark of 0.70. Although CR values above 0.95 may indicate potential item redundancy, the items were retained as they were adapted from established and validated scales and were conceptually distinct, which is considered acceptable when constructs are theoretically well defined and measurement items capture closely related aspects of the same concept (Hair et al., 2017). Convergent validity was evaluated using average variance extracted (AVE), and all constructs recorded values above 0.50, ranging from 0.684 to 0.912, which demonstrated satisfactory convergent validity. Discriminant validity was then tested using the heterotrait-monotrait ratio (HTMT). As shown in Table 3, the correlation values between constructs were below both the HTMT.85 (Kline, 2011) and HTMT.90 thresholds (Henseler et al., 2015). This indicates that the constructs are empirically distinct and do not overlap. Taken together, these results confirm that the measurement model achieved acceptable levels of reliability, convergent validity, and discriminant validity.

Table 2. Factor loading, composite reliability (CR), and average variance extracted (AVE).

Item	Scale	Loadings	CR	AVE
Relative Advantage				
RA1	QR mobile payments offer significant advantages compared to existing payment solutions (e.g. cash, card, NFC)	0.864	0.949	0.822
RA2	QR mobile payments are more beneficial than existing payment solutions (e.g. cash, card, NFC)	0.923		
RA3	QR mobile payments are more efficient than existing payment solutions (e.g. cash, card, NFC)	0.935		
RA4	QR mobile payments are more effective than existing payment solutions (e.g. cash, card, NFC)	0.903		

Item	Scale	Loadings	CR	AVE
Compatibility				
CP1	Using QR mobile payments is compatible with all aspects of my lifestyle.	0.919		
CP2	Using QR mobile payments is completely compatible with my current situation	0.894	0.951	0.828
CP3	I think that using QR mobile payment fits well with the way I like to buy	0.922		
CP4	Using QR mobile payments fits into my lifestyle	0.904		
Complexity				
CX1	QR mobile payments are user-friendly*	0.841		
CX2	QR mobile payments are easy to understand*	0.912	0.938	0.792
CX3	QR mobile payments seem easy to operate*	0.882		
CX4	Paying using QR mobile payments would be relatively easy*	0.923		
Trialability				
TR1	I can experiment with QR mobile payments without having to use them all the time	0.815		
TR2	I can experiment paying with QR mobile payments without having to give up other means of payments	0.850	0.901	0.696
TR3	I can try out QR mobile payments without having to use them all the time	0.896		
TR4	I will be able to test various functions available with QR mobile payments	0.772		
Observability				
OB1	I have seen others use QR mobile payments to pay for goods and services	0.803		
OB2	I have seen people in stores (including food stalls, kiosks, cafes etc.) pay with QR mobile payments	0.847	0.896	0.684
OB3	The benefits of QR mobile payments are highly visible to me	0.835		
OB4	I can easily see the positive outcomes of using QR mobile payments	0.823		
Usage Intention				
UI1	I am planning to use QR mobile payments in the near future	0.924		
UI2	I will use QR mobile payments in the near future	0.971	0.969	0.912
UI3	I intend to use QR mobile payments in the near future	0.969		

*Note: Reverse-coded items.

Table 3. Discriminant Validity via HTMT test

	CP	CX	OB	RA	TR	UI
CP						
CX	0.849					
OB	0.763	0.826				
RA	0.825	0.772	0.590			
TR	0.660	0.670	0.604	0.581		
UI	0.746	0.768	0.782	0.683	0.594	

Note: RA = relative advantage; CP = compatibility; CX = complexity; OB = observability; TR = trialability; UI = usage intention

4.3 Structural model

To evaluate the structural model and test the proposed hypotheses, SEM path analysis was conducted using a bootstrapping procedure with 10,000 resamples, which generated the t-values for each path (Hair et al., 2017). The explanatory power of the model was reflected in the R^2 value of 0.629, indicating that the predictors accounted for a substantial proportion of the variance in usage intention. In addition, the variance inflation factor (VIF) values ranged between 1.526 and 4.285, which are below the recommended threshold of 5, indicating that multicollinearity was not a concern (Hair et al., 2017).

The path analysis results revealed that relative advantage ($\beta = 0.183$, $t = 2.019$) and observability ($\beta = 0.327$, $t = 2.979$) had significant positive effects on usage intention, supporting H1 and H5. Complexity ($\beta = -0.199$, $t = 1.730$) showed a significant negative effect on usage intention, consistent with the hypothesized direction of H3. In contrast, compatibility ($\beta = 0.146$, $t = 1.161$) and trialability ($\beta = 0.065$, $t = 0.828$) did not show significant relationships with usage intention, leading to the rejection of H2 and H4. Overall, these findings highlight that the advantages, ease of use, and visible outcomes of QR mobile payments are more influential in shaping user usage intention than compatibility with lifestyle or opportunities to experiment.

Table 4. Hypotheses testing

Hypo.	Path	Coefficient (β)	Std. error	t-value	Bias Corrected Confidence interval		Decision
					2.5%	97.5%	
H1	RA \rightarrow UI	0.183**	0.091	2.019	0.053	0.351	Supported
H2	CP \rightarrow UI	0.146	0.126	1.161	-0.073	0.344	Not supported
H3	CX \rightarrow UI	-0.199**	0.115	1.730	-0.373	-0.007	Supported
H4	TR \rightarrow UI	0.065	0.079	0.828	-0.065	0.192	Not supported
H5	OB \rightarrow UI	0.327**	0.110	2.979	0.150	0.507	Supported

Note: * $p < 0.05$, ** $p < 0.01$; RA = relative advantage; CP = compatibility; CX = complexity; OB = observability; TR = trialability; UI = usage intention

5. Discussion

Relative advantage emerged as a primary driver of usage intention, suggesting that users prioritize tangible benefits when evaluating QR mobile payments. According to DOI theory, innovations that offer clear functional and economic benefits are more likely to stimulate usage intention (Rogers, 2003). In the Malaysian context, this reflects a preference for convenience, speed, and accessibility compared to traditional payment methods. Additional factors, such as cashless incentives, integration with multiple e-wallet platforms, and supportive government initiatives, further reinforce these advantages. These findings are consistent with prior studies showing that innovations with clear functional and economic benefits increase usage intention (Alalwan et al., 2017; Nguyen et al., 2023). In contrast to research in Western contexts, where perceived usefulness often dominates (Venkatesh & Davis, 2000), practical and social benefits appear to drive usage intention in emerging digital markets.

Complexity's negative effect suggests that users are sensitive to effort and usability challenges. DOI theory posits that innovations perceived as difficult to understand or use experience slower diffusion (Rogers, 2003). In Malaysia, consumers who encounter unclear processes, technical disruptions, or complicated interfaces may avoid using QR mobile payments, preferring familiar methods such as cash or debit cards (Leong et al., 2020). This aligns with prior findings indicating that higher perceived difficulty reduces ease of use and usage intention (Hasan, 2007; Lee et al., 2011). Recent research further highlights

that simplifying user interfaces enhances perceived ease of use, which in turn improves usage intention in digital payment systems (Nguyen et al., 2023; Wong et al., 2024).

Observability positively influenced usage intention by increasing social legitimacy and acceptance of QR payments. DOI theory suggests that visible results within a social system enhance perceived value and motivate adoption (Rogers, 2003). In Malaysia, widespread visibility of QR codes and peer usage likely accelerated diffusion among consumers (Ibrahim et al., 2019). This finding aligns with prior studies reporting that observable usage enhances perceived usefulness and ease of use (Lee et al., 2011; Yuen et al., 2020). Unlike mature markets, where social visibility is less decisive, the Malaysian context underscores the importance of observability in accelerating usage intention in emerging digital ecosystems.

The non-significant effect of compatibility suggests that alignment with existing routines or values may be less critical in this context. DOI theory typically predicts that compatibility facilitates adoption, but contextual factors such as the novelty of the technology, pandemic-driven exposure, and promotional incentives may reduce its impact (Agarwal & Prasad, 1999; Hardgrave et al., 2003). Unlike other technologies that extend existing practices, QR payment usage often requires behavioral changes, such as scanning codes, maintaining e-wallet balances, or ensuring internet access. This contrasts with studies in mature markets where compatibility significantly predicts adoption, indicating that contextual factors shape the relative importance of DOI attributes.

Similarly, trialability did not significantly influence usage intention. DOI theory suggests that opportunities to experiment reduce perceived risk and encourage adoption (Rogers, 2003); however, in Malaysia, widespread exposure to QR payments during the COVID-19 pandemic diminished the relevance of risk-free trial experiences (Hamzah, 2024; Yuen et al., 2020; Shareef et al., 2022). This interpretation explains the null effect and aligns with research indicating that high visibility and social normalization of an innovation can reduce the importance of trialability.

5.1 Theoretical implication

This study makes several theoretical contributions. First, it extends research on mobile payment usage intention by applying the Diffusion of Innovation (DOI) framework (Rogers, 2003) to QR-based mobile payments in Malaysia, where prior studies predominantly applied TAM and UTAUT perspectives (Ong et al., 2023; Ahmad Ramli & Hamzah, 2021; Ibrahim et al., 2019). While previous research emphasizes ease of use, perceived usefulness, or trust, the present study demonstrates that DOI innovation attributes are equally critical, particularly in emerging economies with government-driven cashless initiatives.

The findings refine DOI theory by showing that not all innovation attributes exert the same influence across contexts. Relative advantage, complexity, and observability emerged as significant predictors of usage intention, whereas compatibility and trialability did not. In contrast to prior studies where compatibility and trialability were significant (Agarwal & Prasad, 1999; Lee et al., 2011), this study highlights the contextual sensitivity of DOI constructs, suggesting that infrastructural visibility and functional benefits may outweigh alignment with existing routines or opportunities for experimentation in emerging markets.

Furthermore, this research advances understanding of financial technology adoption by demonstrating that observable usage and perceived functional benefits are stronger determinants of usage intention than personal congruence or trial experiences. This provides a nuanced perspective on DOI's applicability, indicating that social visibility and ecosystem-level promotion can supersede personal experimentation in influencing adoption behavior.

5.2 Practical implication

Relative advantage's central role indicates that QR mobile payment providers should emphasize tangible benefits such as speed, convenience, safety over traditional methods, consistent with DOI theory. Contrasting with contexts where compatibility or trialability drive adoption, emphasizing practical benefits can be a more effective strategy to boost its adoption in Malaysia. Complexity's negative influence underscores the importance of minimizing perceived barriers through intuitive interfaces, standardized procedures, and streamlined onboarding. While some studies suggest complexity is less critical in other regions (Shaw et al., 2022; Pan et al., 2022), these findings reinforce its contextual significance in emerging markets.

Likewise, observability enhances adoption by increasing legitimacy and social acceptance. Providers and merchants can leverage signage, promotional incentives, and peer influence. This reflects DOI's principle that visible benefits accelerate diffusion, especially in markets where QR payments are rapidly normalized. Given the non-significance of compatibility and trialability, resources may be better allocated toward increasing visibility and usability rather than trial-based promotions or aligning with existing routines, contrasting with findings from other countries.

5.3 Limitations

Despite its contributions, this study has several limitations that should be acknowledged. First, the sample size of 102 respondents in the Klang Valley may limit the generalizability of the findings to the broader Malaysian population, particularly rural areas where digital payment adoption may differ. Second, the cross-sectional design captures adoption intention at a single point in time, preventing causal inferences about changes in user behavior over time. Third, the study focuses exclusively on QR-based mobile payments, so results may not generalize to other digital payment technologies or fintech innovations. Fourth, self-reported survey responses may be subject to response biases, although procedural and statistical remedies were applied to reduce common method variance.

Finally, while DOI theory provides a robust framework for understanding innovation adoption, other theoretical perspectives such as TAM, UTAUT, or behavioral economics models that may offer additional insights into adoption behavior, particularly regarding trust, perceived risk, or habit formation. Future studies could integrate multiple theoretical lenses to obtain a more comprehensive understanding of adoption determinants.

5.4 Future research

Building on DOI theory, future research can explore several avenues. First, longitudinal studies could examine how the influence of DOI factors such as relative advantage, complexity, and observability evolves as QR mobile payments become more established, providing insights into the diffusion process over time. Next, future studies could investigate potential moderators or mediators within the DOI framework, such as social influence, technological literacy, or perceived risk, to explain when and why certain factors (e.g., compatibility, trialability) become more or less relevant in adoption decisions. Furthermore, comparative studies across countries or regions with varying levels of digital payment maturity could test the generalizability of DOI constructs, identifying contextual factors that enhance or diminish the salience of each innovation attribute.

In addition, integrating DOI theory with complementary frameworks (e.g., TAM, UTAUT, or behavioral economics) could provide a more nuanced understanding of adoption drivers, particularly regarding user trust, habit formation, or incentive mechanisms. Finally, future research could investigate adoption at the ecosystem level, considering how merchant penetration, interoperability, and government initiatives interact with DOI factors to influence consumer behavior, reflecting a more holistic, context-sensitive application of the theory.

6. Conclusion

This study advances the growing body of literature on mobile payment adoption by employing the Diffusion of Innovation (DOI) framework to examine how innovation attributes shape users' intention to adopt QR mobile payments in Malaysia. The findings demonstrate that relative advantage, complexity, and observability are significant predictors of adoption, whereas compatibility and trialability were not supported. These results suggest that Malaysian consumers are primarily motivated by the tangible benefits, ease of use, and social visibility of QR payments, rather than by lifestyle alignment or opportunities to experiment with the technology prior to adoption. From a practical standpoint, the findings offer important implications for banks, fintech providers, and policymakers. Efforts to emphasize the comparative benefits of QR payments, simplify user experiences, and enhance visibility in retail and everyday contexts are essential for sustaining adoption. In contrast, the limited role of compatibility and trialability indicates that achieving widespread usage depends less on tailoring services to individual lifestyles or offering trial opportunities, and more on mainstreaming the technology through convenience, efficiency, and peer influence.

Beyond the Malaysian context, this study underscores the relevance of DOI theory for understanding digital payment adoption in emerging economies, where cash remains dominant and infrastructure is still evolving. As QR mobile payments continue to expand, they are expected to play a pivotal role in advancing the national digital economy agenda and accelerating the transition toward a cashless society. Future research could build on these insights by examining cultural and demographic variations across markets, as well as investigating the roles of trust and security in shaping long-term adoption and continued usage.

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Conflict of interest statement

The author(s) declare that this research was conducted in the absence of any self-benefits, commercial or financial interests that could influence the work reported in this paper.

Ethics statement

This study adhered to established ethical research standards. Informed consent was obtained from all respondents prior to data collection, and participants were assured of anonymity and confidentiality. No experimental procedures involving human subjects were conducted.

Declaration of generative AI

Generative AI was not used during the preparation of this work.

Data availability/supplementary materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

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Authors' contributions

F.A.A. carried out the research, analyzed, visualized the data, and wrote the original manuscript. M.I.H, conceptualized the methodology and theoretical framework. M.I.H supervised research progress. Both M.I.H and N.A.A.Y.M revised and edited the manuscript.

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