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Enablers and disablers for contactless payment acceptance among Malaysian adults

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While a body of knowledge on contactless payment acceptance exists, a comprehensive understanding of the core motivations underpinning such acceptance, particularly in developing countries, is lacking in the literature. This study identified the predictors for contactless payment acceptance in Malaysia by constructing a Contactless Payment Acceptance model using the Technology Readiness Index 2.0 and the Unified Theory of Acceptance and Use of Technology 2 models. Employing a cross-sectional research design, this study utilized survey research as its primary method, administered self-reporting questionnaires through online channels, and garnered 434 valid responses. Structured Equation Modeling identified perceived usefulness, perceived ease of use, lack of awareness, and discomfort as the most influential factors affecting customers' acceptance of contactless payment systems, with an *R*-squared value of 71.2%. These results have implications for service providers and can guide future research endeavors, thus facilitating the development and implementation of effective strategies to encourage wider adoption of contactless payment systems among individuals in developing countries.

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Introduction

Contactless or cashless payments refer to electronic methods of conducting financial transactions typically made using digital wallets (e-wallets), smartphones, or smart cards that utilize technologies such as Near Field Communication (NFC) to facilitate secure and convenient transactions by simply tapping or waving the payment device near a compatible terminal (Fabris, 2019). Compared to the other regions, the adoption, implementation, and use of contactless payments in Southeast Asia has been relatively sluggish. For instance, a recent report revealed that although contactless cards are popular in Southeast Asia, where 95% of consumers are aware of it, only 65% use them (Lamb, 2021).

However, the recent COVID-19 pandemic has accelerated the acceptance of contactless payments as consumers prioritize safety and convenience. This shift has been encouraged by factors such as widespread smartphone use, government support, and the emergence of fintech solutions. Countries like Singapore, Malaysia, and Thailand are at the forefront of promoting contactless transactions, with a surge in mobile payment apps and e-wallets. For instance, popular platforms like GrabPay, Touch n Go e-Wallet, and Boost have become popular among Malaysians for various transactions. For instance, a recent survey revealed that a total of 74% of Malaysians used contactless payments for their retail purchases in 2022, an increase from 56% recorded in 2021 (The Star, 2023). However, despite several government-led promotion campaigns to boost contactless payments, implementing this technology in Malaysia has met some resistance (Ong et al., 2023). The contactless payment ecosystem is expected to continue evolving; hence the factors influencing the acceptance of this technology from the consumer's standpoint, especially from developing nations such as Malaysia, should be elucidated. The present study, therefore, aims to answer the following research question (RQ):

> RQ: What are the key enablers and disablers for contactless payment acceptance among Malaysians?

Most studies on contactless payment have adopted or extended some well-known technology acceptance theories, such as Technology Acceptance Model (TAM) (Türker et al., 2022; Gunawan et al., 2023) and the Unified Theory of Acceptance and Use of Technology 1 and 2 (UTAUT) (Sleiman et al., 2023; Zhao, Bacao 2021; Al-Saedi et al., 2020; Tam et al., 2020). Other theories including the personality trait-based Technology Readiness Index 1 and 2 (TRI) (Parasuraman, 2000; Parasuraman and Colby, 2015) are under-researched in contactless payment studies. Factors such as performance expectations, social influence, and convenience (Mohamed et al., 2020; Faletehan et al., 2020) are often cited as influencing contactless payment adoption, whereas privacy and perceived risks emerge as the main barriers (Padmawidjaja et al., 2020; Ozturk, 2016; Ong et al., 2023). However, other factors, including status, fun, and enjoyment, have yet to be fully investigated in contactless payment studies, although these have been shown to motivate the uptake of smartphones (Malik et al., 2017; Olasina and Kheswa, 2021). To fill these gaps, we developed a Contactless Payment Acceptance Model (CPAM)—an integrated model—to investigate the influential factors (i.e., enablers and disablers) adapted from UTAUT 2 and TRI 2.0 and further extended with factors identified from previous literature.

Theoretical underpinning and hypotheses

A synthesis of previous studies revealed that the majority have examined contactless payment influential factors through single behavioral and intention frameworks/models, such as the TAM (Davis, 1989), Theory of Planned Behavior (TPB) (Ajzen, 1991), and UTAUT (Venkatesh et al., 2003) and its extended versions as well as Social Cognitive Theory (SCT) (Bandura, 1986) and Innovation Diffusion Theory (IDT) (Rogers, 2003). For example, TPB, which is an extension of the Theory of Reasoned Action (TRA) (Fishbein and Ajzen, 1980) posits that individuals make rational decisions based on their intentions, which are influenced by attitude, subjective norms, and Perceived behavioral control. Within the context of contactless payment, authors such as Flavian et al. (2020) and Giovanis et al. (2019) have incorporated TPB to delineate consumers' views regarding the requisite knowledge, resources, and opportunities needed to make use of the service.

A popular theory in technology acceptance is TAM, which posits that users' behavioral intentions toward technology are influenced by two factors—perceived usefulness (the degree to which a person believes using the technology will enhance their performance) and perceived ease of use (the extent to which a person believes using the technology will be free of effort) (Davis, 1989). TAM and its extensions have been employed in a variety of applications across disciplines, settings, and geographies, and serve as an important theoretical tool for forecasting user behavior, including in contactless payment technologies (Türker et al., 2022; Gunawan et al., 2023). Specifically, a recent review paper ($n = 128$ published from 2013 to 2023) identified TAM as the most used theory in digital payment technology studies ($n = 59$), followed by UTAUT ($n = 52$) (Ramayanti et al., 2023), probably due to its simplicity and efficiency in analyzing technology acceptance.

In 2003, Venkatesh et al. (2003) proposed UTAUT—a model that integrates various constructs from existing technology acceptance models, including TAM, TRA, and the Innovation Diffusion Theory (IDT). UTAUT identifies four core determinants of technology acceptance: performance expectancy, effort expectancy, social influence, and facilitating conditions. In 2012, the authors further extended UTAUT by including hedonic motivation (pleasure and enjoyment derived from using technology), price value (perceived economic cost of using the technology), and habit (the extent to which individuals develop automatic and routine behaviors related to technology use over time) (Venkatesh et al., 2012). The extended model, UTAUT 2, was reported to have a higher predictive ability than UTAUT (74% vs. 52%) (Venkatesh et al., 2016) as well as TAM (Albanna et al., 2022). It has been widely validated by many empirical studies, including those investigating contactless payment systems (Sleiman et al., 2023; Zhao, Bacao 2021; Al-Saedi et al., 2020; Tam et al., 2020). For instance, a recent study extended UTAUT by including social distancing and fear of COVID-19, and the results demonstrated that performance expectancy, trust, perceived security, and social influence significantly influence the acceptance of mobile payment, with social distancing having the greatest impact, followed by fear of Covid-19 (Berdibayev and Kwon, 2021).

On the other hand, personality trait-based models such as TRI 1.0 and its extended version TRI 2.0 encompass general beliefs toward technology in the form of enablers and barriers (Parasuraman, 2000; Parasuraman and Colby, 2015). The TRI 1.0 model was developed in 2000 by Parasuraman (2000), and it encompasses 36 aspects intended for the measurement of the structure and its key components. This was, however, refined to 16 aspects, resulting in a simplified TRI 2.0 version. TRI 2.0 essentially evaluates the perspective of an individual toward the advancements in technology in general (Parasuraman and Colby, 2015). The model includes two enablers (i.e., optimism and innovativeness) and two disablers (discomfort and insecurity) (Parasuraman and Colby, 2015). Similar to UTAUT 2, the model

has been used to measure several technology adoptions, such as Information and Communication Technology (ICT) services for tourism (Dayour et al., 2023); however, it is less applied in the field of contactless payment.

Based on the above theoretical reviews, UTAUT2 and TRI 2.0 were identified as the two key models in the development of CPAM. In the context of contactless payment, scholars have adopted UTAUT2 as is or adapted it by combining other theories (fully or partially) (Oliveira et al., 2016; Semerikova, 2019) or incorporating other relevant factors, such as trust (Alalwan et al., 2017; Alkhowaiter, 2022; Patil et al., 2020), security (Ong et al., 2023), and security and sensitization (Malinga and Maiga, 2020). We adopted a similar approach in this study, in which UTAUT2 was partially adapted by including performance and effort expectancy, and hedonic motivation. Further, considering the high smartphone penetration in Malaysia (i.e., 89%) (Statista, 2023) as well as the emphasis on the individual personality trait model (i.e., TRI 2.0), factors such as facilitating condition, social influence, and price were excluded. As for TRI 2.0, all four enablers and disablers were adapted in CPAM.

CPAM was further extended by incorporating additional factors from previous research that have been identified as major enablers and disablers of customers' acceptance of contactless payment systems, including lack of awareness (Aris et al., 2022; Al-Okaily et al., 2022), compatibility (Türker et al., 2022; Humbani and Wiese, 2017; Yang et al., 2021), and status symbols (Sen, 2020; Shekhar et al., 2020). Notably, although some studies have used "image" to measure social influence from UTAUT2, we treated status symbols as an individual factor, as the true definition of social influence should encompass peer, family, and societal influence (Verma and Sinha, 2018). All the factors and their respective hypotheses are presented next.

Hypothesis. According to Humbani and Wiese (2017), the term "acceptance" essentially resonates with the decisions of an individual with regard to the integration of technology and innovation in their daily lifestyle. Consumer acceptance could also imply the user's knowledge of technology and its relationship to a contactless society. Specifically, no concrete definition correlating the term exists; however, the common ground is its indication of the propensity to accept new contactless technology as part of a payment medium (Humbani and Wiese, 2017). The term "contactless payment acceptance" is used throughout this paper to reflect the same.

Perceived ease of use. The notion behind the perceived ease of use in understanding user readiness stems from the degree to which an individual considers a designated system to be effortless. User attitudes and behavioral inclinations toward embracing and utilizing technology are notably shaped by their perception of its ease of use (Chawla and Joshi, 2020). It is well-established that a customer's decision to make a purchase is significantly influenced by their perception of the ease with which they can use a particular technology. For example, many clients have characterized their experiences with e-wallet software as uncomplicated and thus would adopt it (Hamid et al., 2016). Based on this, we posit that perceived ease of use positively influences contactless payment acceptance among Malaysians. Therefore, the first hypothesis is formulated as follows:

H1: Perceived ease of use positively influences contactless payment acceptance.

Perceived usefulness. According to Davis (1989), the term perceived usefulness is defined as an individual's view of the use of new technology that will increase or improve their present performance. Perceived usefulness has a direct impact on both the attitude toward system use and the behavioral intention to use the system; it is also significantly influenced by the perceived ease of use attribute (Bradley, 2009). A study in Iran reported perceived usefulness to have a direct impact on the usage of mobile banking, principally resonating with the demographics of the respondents, whereby the majority were young, educated adults (Mohammadi, 2015). Similar results were reported in other studies, whereby perceived usefulness was found to motivate the adoption of online technology (Lekmat, 2018; Mohamed et al., 2020; Faletehan et al., 2020). Perceived usefulness has a significant and positive impact on user adoption intentions in a wide variety of circumstances; hence, the following hypothesis is proposed:

H2: Perceived usefulness positively influences contactless payment acceptance.

Optimism. Optimism relates to having positive views of products or services, including customer beliefs of control, flexibility, convenience, and efficiency (Parasuraman, 2000; Parasuraman and Colby, 2015), and research has suggested that optimism is a motivating factor in the desire to utilize technology (McLean et al., 2019). The optimism factor was explored by Parasuraman and Colby (2015) in their TRI 2.0 model, who carefully justified the driving and inhibiting factors of society's technology readiness. Their study deduced that optimism is an enabling factor of technology acceptance; a person optimistic toward the notion of technology easily accepts and integrates it into their daily life, similar to individuals with innovative traits (Parasuraman and Colby, 2015). Optimists fundamentally possess optimistic opinions, which consequently facilitates the advancement of more propitious viewpoints concerning new technologies. Because technology optimists often foresee ideas and matters to go their way and trust that great things will occur to them more readily than bad things, they have an instinctive optimistic perception of new technologies owing to their self-confidence in their ability to grasp new technologies (Nagdev et al., 2019). Therefore, hypothesis three is formulated:

H3: Optimism positively influences the contactless payment acceptance.

Compatibility. Focusing on the notion of compatibility in terms of lifestyle, it is colloquially defined as the natural configuration of preferences and principles associated with the lifestyle of consumers. Fundamentally, this attribute of compatibility is integral to minimalizing the degree of ambiguity corresponding to the usage of technology and its correlation to the principles, skills, lifestyle, and choices of the individual. Briefly, the lifestyle compatibility of an individual plays an important role in the adoption of contactless payment systems (Yang et al., 2021). Humbani and Wiese (2017) and Türker et al. (2022) found that compatibility was vital to integrating mobile-based payment software as part of an individual's daily lifestyle. This is primarily associated with their spending behavioral patterns and habits. Individuals inclined toward shopping and who can adapt to technological advancements are likely to adopt contactless transactions, especially owing to their convenience (Humbani and Wiese, 2017). Therefore, hypothesis four is formulated as follows:

H4: Compatibility positively influences contactless payment acceptance.

Enjoyment. Perceived enjoyment is characterized as a pleasurable and investigative psychological understanding from the perspective of information technology and computer-facilitated settings. The amount to which the action of utilizing a certain system is regarded to be pleasurable or enjoyable in and of itself, independent of any performance outcomes ensuing from system use,

is referred to as expressed perceived enjoyment (Kiwanuka, 2015). Perceived enjoyment is a key factor in deciding whether to utilize a system or service (Kiwanuka, 2015; Holdack et al., 2020; Bailey et al., 2019). Research by Chin and Ahmad, (2015) on the effect of perceived enjoyment on the usage intention and adoption of a single-channel e-payment platform among Malaysians found that the relationship between enjoyment and customer's intention of e-payment usage was heavily influenced by usefulness and ease of use. Therefore, when customers believe that the single-platform e-payment system is very fun, simple to use, and beneficial, they are more likely to use it (Chin, Ahmad, 2015). Therefore, hypothesis five is formulated as follows:

H5: Enjoyment positively influences contactless payment acceptance.

Status symbol. Status symbols are vital to individuals, particularly as they allow them to preserve social class by incorporating digital media into their daily lives (Sen, 2020). According to Sen (2020), status symbols emerged as one of the driving factors in digital economy adoption, and they reflect the requirement for participants to use digital media in their careers or personal lives to retain a social class. This has positively motivated most participants to become aware of the benefits of digitalization and, thus, to become active participants in the digital economy. Similar studies in India reported that e-wallets are considered as a fashion statement, a sign of luxury, modernity, and technological supremacy by the respondents, whereas those not skilled at using cashless transactions were regarded as less contemporary or as having a lower social rank (Sen, 2020). A gender-based study revealed that in terms of women's empowerment, performing transactions in a contactless method was a symbol of status among employed women (Rathika, Mitrapriya, 2018). However, contrary to these findings, Dhingra et al. (2020) revealed that the ability to use e-wallets from anywhere is the most compelling reason for embracing their use, and they are not seen as a status symbol. Based on most of the results, we posit that status symbols will have a positive influence, hence hypothesis six is given as follows:

H6: Status symbol positively influences contactless payment acceptance.

Innovativeness. Personal innovativeness is defined as an individual's willingness to experiment with new information systems, and it has a large and beneficial impact on digital payment services. Personal innovativeness is regarded as a characteristic and a generally consistent description of an individual that is unaffected by external or internal influences across settings (Raj et al., 2023). An individual with higher personal innovativeness is more likely to accept a new idea sooner. Innovativeness should be rethought to forecast a person's technological adoption. Moreover, people with greater degrees of personal creativity in information technology are more likely to have positive attitudes about innovation. Therefore, such a person's intentions regarding the adoption of contactless payments may be more positive (Rahman et al., 2021). Hypothesis seven is given as follows:

H7: Innovativeness positively influences contactless payment acceptance.

Lack of awareness. According to Rogers (2003), awareness relates to a user's knowledge of the capabilities of a technology, its features, potential use, and cost and benefits. Having sufficient knowledge and understanding about a technology implies a higher level of awareness among consumers and, hence, a higher technology adoption. Therefore, in the context of contactless payments, a lack of awareness can significantly impede contactless payment adoption among consumers. When individuals are unfamiliar with the existence and benefits of contactless payment methods, they are less likely to explore or trust these technologies. This limited awareness can lead to misconceptions about security and convenience, causing potential users to stick with the traditional payment methods that they are more familiar with (Aris et al., 2022; Al-Okaily et al., 2022). Additionally, without knowledge of contactless options, consumers may miss out on the speed and efficiency that these methods offer. Therefore, it is hypothesized that a lack of technology awareness indicates a lower level of technology acceptance. H8 is given as formulated as follows:

H8: Lack of awareness negatively influences contactless payment acceptance.

Discomfort. A sense of being overwhelmed by technology and a perceived lack of control over it is characterized as discomfort. Users who have a high level of discomfort feel out of control and overwhelmed by technology (Kim, Lee, 2014). Therefore, they regard technology as more challenging. Previous research has found that high degrees of discomfort concerning technology may lead to unfavorable attitudes about technology (Humbani and Wiese, 2017). A study by Sharma, (2020) in India revealed that discomfort significantly influences users' intention to adopt contactless payments. Statistically, discomfort has a 74.4% influence in reducing the chances of a user adopting contactless payments as their new payment medium, corresponding to other contributing factors, such as convenience, optimism, innovation, and insecurity (Sharma, 2020). As the factor tends to have a negative influence, we posit the following hypothesis:

H9: Discomfort negatively influences contactless payment acceptance.

Perceived insecurity. Perceived insecurity, which is more commonly referred to as risk in most works, is a natural perception of unreliability regarding the potential for the undesirable usage of a service or product (Nguyen and Huynh, 2017). It encompasses distrust and skepticism about its ability to work, and individuals may feel that there are some risks when using new technologies. A study involving 200 respondents from Ho Chi Minh City found that perceived risk significantly impacted other inhibiting factors associated with the adoption of electronic payments in Vietnam, such as trust, perceived ease of use, and usefulness (Nguyen and Huynh, 2017). Similarly, the factor was found to partially affect the behavioral intention of users in adopting the medium for contactless transactions in India (Padmawidjaja et al., 2020). This corroborated the findings of Ozturk (2016) who found that perceived risk negatively impacts the perceived ease of use, usefulness, and usage intention of contactless transactions in the hospitality industry. The final hypothesis is given as follows:

H10: Perceived insecurity negatively influences contactless payment acceptance.

Materials and methods

Research model. Figure 1 depicts the conceptual framework for CPAM, along with the dependent and independent variables, as well as the hypotheses formulated in the section "Hypothesis".

We identified seven drivers (H1–H7), three disablers (H8–H10), and one dependent variable, namely contactless payment acceptance. The operational definitions are given in Table 1:

Procedure. This cross-sectional study adopted the convenience sampling approach to gather data via emails (shared Google links) and social media sites such as Facebook and WhatsApp. The selection of a non-probability convenience sampling

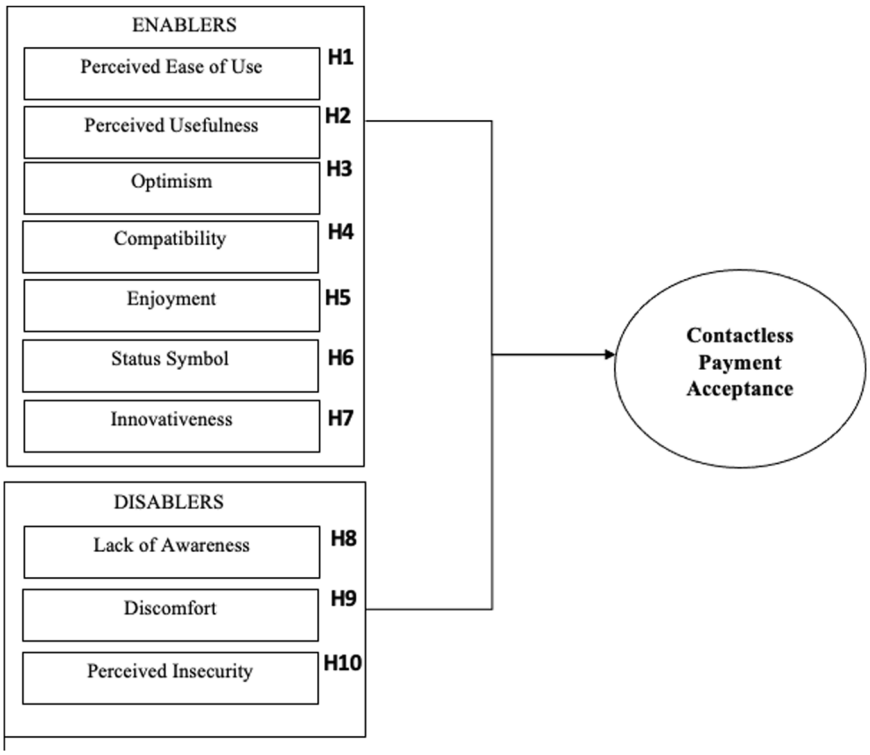

Fig. 1 Contactless Payment Acceptance Model (CPAM). This figure illustrates all the enablers and disablers hypothesized to affect Contactless Payment Acceptance (H - Hypothesis).

Table 1 Operational definitions for all the variables.

Factors	Model/references	Definition
Perceived usefulness	UTAUT2 (Performance expectancy)	Degree to which a person believes that using contactless payment would enhance his/her job performance
Perceived ease of use	UTAUT2 (Effort expectancy)	The extent to which using contactless payment is easy.
Innovativeness	TRI 2.0	Inclination of an individual to try out new contactless payment
Optimism	TRI 2.0	Positive view of contactless payment technology and a belief that it offers people increased control, flexibility, and efficiency in their lives
Compatibility	Yang et al. (2021); Humbani and Wiese (2017); Türker et al. (2022)	Consistency between contactless payment technology and its values, experiences, and the needs of potential adopters.
Status symbol	(Sen, 2020; Dhingra et al., 2020; Rathika, Mitrapriya, 2018; Shekhar et al., 2020)	The extent to which using contactless payment is deemed a status symbol
Enjoyment	UTAUT 2 (Hedonic motivation)	The extent to which using contactless payment is considered fun
Lack of awareness	(Aris et al., 2022; Al-Okaily et al., 2022)	The lack of knowledge pertaining to contactless payment technologies, including benefits
Perceived insecurity	TRI 2.0	Perceived insecurity is the degree to which people believe it will lead to adverse outcomes, including money loss, fraud, or identity theft
Discomfort	TRI 2.0	Perceived lack of control over contactless payment and a feeling of being overwhelmed by it
Contactless payment acceptance	Own	The level of propensity in accepting contactless payment technologies.

technique for data collection was a pragmatic choice driven by the challenges of obtaining a specific sampling frame and the convenient accessibility of the targeted respondents (Sarstedt et al., 2017). Nevertheless, procedural and statistical measures were meticulously applied to enhance the study's internal validity and provide a robust analysis of the collected data. The minimum sample size was determined to be 207 based on the G*Power software, with a small effect size of 0.20 and a 0.05 level of significance with a power of 0.90 (Kang and Nyang, 2017). The number of valid responses collected was 434. The data collection was done in accordance with the research protocol and guidelines approved by the university. All the respondents were informed that the data collected would be treated with the strictest confidentiality, and they were anonymized. They were also informed that they had the decision to withdraw at any time.

Instrument. A quantitative questionnaire comprising statements to evaluate each of the enablers and disablers, as shown in Fig. 1, was developed to assess the respondents' contactless payment acceptance level. Part A of the questionnaire predominantly solicited the respondents' demographic information, that is, age (continuous), gender (dichotomous), education background

(ordinal), income (ordinal), frequency of weekly usage (ordinal), and types of digital payment services used (dichotomous). Subsequently, Part B encompasses elements principally specifying individual enablers, disablers, and the dependent variable. These were measured using a four-point Likert scale (1 = Strongly disagree and 4 = Strongly agree). A pilot study was conducted among 30 respondents, and no major issues regarding the design and formulation of the statements were reported. The complete questionnaire can be found in Appendix A.

Respondents. There was a total of 434 respondents aged between 18 and 64 years old. Of these, females outnumbered males by 13% (246 vs. 188). Most of the respondents were aged between 25 and 50 years old (77.2%), followed by those below 25 (17.5%), whereas the remaining 5.3% were more than 51 years old. This tendency can be attributed to the use of online questionnaires, which results in a respondent demographic that skews toward younger users. Almost 64% had tertiary-level academic backgrounds, followed by respondents who had postgraduate degrees (35.5%). Only 1% had a high-school education; hence, the sample is considered young and educated. Further, 42.9% of the respondents used contactless payments at least 4–9 times per week; 41.0% less than three times per week, and the remaining 16.1% more than ten times per week. A significant number of the respondents used contactless payments (92.4%), and of these, 36.1% used several services or apps. GrabPay, Maybank QR Pay, JomPay, and Boost were revealed to be the four most popular payment services among our survey respondents.

Data analysis. Statistical Package for Social Sciences (SPSS) 27 was used to characterize the sample using descriptive statistics. The CPAM model was assessed and validated through Structured Equation Modeling (SEM) using IBM SPSS@AMOS version 25. The model was evaluated for reliability, parameter estimation, and hypothesis testing. The factor loadings threshold was set to 0.70 (Hair et al., 2014); Cronbach's alpha (CA) (Nunnally and Bernstein, 1994) and composite reliability (CR) (Hair et al., 2009; 2014) was set to 0.70; and average variance of extraction (AVE) was set to 0.5 (Fornell and Larcker, 1981; Zahoor et al., 2022) to assess convergent validity. Discriminant validity was assessed using the Fornell and Larcker, (1981) criterion, in which validity is established when the latent variable explains the variance of the indicators more than another latent variable. The chi-square/degree of freedom(χ^2/df), comparative fit index (CFI), goodness-of-fit index (GFI), root mean square error of approximation (RMSEA), and standardized root mean square residual (SRMR) were used to assess CPAM's goodness-of-fit, as recommended by Hu and Bentler (1998).

Results

This section presents the results, beginning with the reliability evaluation and moving to the proposed model and the hypotheses.

Reliability and validity evaluation. Innovativeness and perceived insecurity were excluded from further analysis due to low factor loadings for all the items (i.e., less than 0.6; Hair et al., 2014). Table 2 lists the reliability evaluation and comprises parameters such as the CA, CR, and AVE. All the scores were above the recommended thresholds; hence the model's reliability is established.

Table 3 illustrates the Fornell-Lacker, (1981) results; all the bold items (shown diagonally) are higher than other latent variables, hence discriminant validity is established.

Goodness-of-fit. As for CPAM's goodness of fit measure, all the scores indicated a satisfactory fit, as listed in Table 4.

Modeling. Figure 2 depicts the complete outcome of SEM, along with the regression coefficients and factor loadings. The R^2 for CPAM was 71.2%. Table 5 summarizes the hypotheses testing, which indicates four significant factors. Specifically, perceived ease of use and perceived usefulness (enablers) and lack of awareness and discomfort (disablers) were found to significantly affect contactless payment acceptance among our study sample. Finally, Fig. 3 summarizes the SEM and hypotheses results.

Perceived usefulness was found to be the most significant predictor ($\beta = 2.64$, $p = 0.001$; $t = 4.965$), followed by perceived ease of use ($\beta = 2.06$, $p = 0.001$; $t = 3.750$). Both these enablers had positive path relationships, which supports H1 and H2. The emergence of perceived ease of use and usefulness well aligns with the findings of previous studies (Mohamed et al., 2020; Shbiel and Ahmad, 2016; Singh et al., 2020), hence indicating aspects such as time-savviness, efficiency, better decision-making skills, and ease of performing comparisons and evaluating had a strong influence on the acceptance level of the technology. Individuals are more inclined to adopt contactless payments as they see tangible advantages in their daily transactions. Simultaneously, ease of use determines how effortlessly consumers can navigate and utilize the technology. When contactless payments are easy to understand and use, barriers to adoption are lowered, making it more likely for individuals to embrace these methods. In combination, these factors create a positive user experience and foster greater acceptance and integration of contactless payments into everyday life. Given that most respondents in this study are educated and often use contactless payment services, they may possess the necessary knowledge and confidence to use these services.

Two disablers were found to significantly affect contactless payment acceptance, namely discomfort ($\beta = -0.43$, $p = 0.001$; $t = -3.582$) and lack of awareness ($\beta = -0.33$, $p = 0.008$; $t = -2.649$). The negative coefficients indicate that the higher the discomfort and lack of awareness, the lower the acceptance of contactless payments (H8 and H9 supported). The outcome of discomfort corroborated the findings from previous studies (Kim, Lee, 2014; Verkijika, 2018; Kang and Nyang, 2017; Humbani and Wiese, 2017; Sharma, 2020). Using contactless payment methods can be tedious for some individuals due to the perceived complexities involved in setting up and managing digital wallets and monitoring credit balances, as well as the inconvenience of carrying electronic devices such as smartphones or laptops, which are often required for contactless transactions. This perceived hassle can deter people from embracing contactless payments.

The emergence of lack of awareness as a significant disabler demonstrates that most of the surveyed respondents perceive themselves as lacking knowledge about the existence, functionality, or advantages of contactless payment systems. This corroborates previous studies that reported concerns about adopting contactless payment systems due to a lack of understanding of how personal data were managed (Semerikova, 2019) or the underlying technology itself (Aris et al., 2022; Al-Okaily et al., 2022). In addition to considering other significant factors, such as user resistance and the state of the existing infrastructure (Oliveira et al., 2016), the successful transition to contactless payment systems necessitates a concerted effort from relevant authorities, including government bodies, to promote the technology, including its use, implementation, and security measures to the public.

The remaining factors were found to be insignificant (i.e., status symbol, compatibility, enjoyment, and optimism). This could be attributed to several reasons. For instance, the status

Table 2 Contactless Payment Acceptance Model results.

Construct	Items description	Factor loading	Mean (SD)	CA	AVE	CR
Perceived ease of use	PEOU1: I find it easy to use contactless payments	0.81	3.45 (0.72)	0.83	0.63	0.82
	PEOU2: I find it easy to learn to use contactless payments	0.74				
	PEOU3: I find it easy to install a contactless payment application	0.82				
Perceived usefulness	PU1: Using digital payment would help me to manage my expenses better	0.66	3.35 (0.76)	0.80	0.61	0.77
	PU2: It is convenient to pay digitally	0.80				
	PU3: Contactless payment enables me to make payment efficiently	0.86				
Optimism	OPT1: I believe payments can be successfully completed using contactless payments	0.78	3.38 (0.71)	0.86	0.61	0.73
	OPT2: I feel that contactless payment is the lead towards the future.	0.80				
	OPT3: I believe that contactless payment provides flexibility	0.77				
Compatibility	COM1: My lifestyle fits contactless payment	0.80	3.34 (0.74)	0.74	0.57	0.72
	COM2: I have the means to use contactless payment (e.g., smartphones)	0.71				
Enjoyment	ENJ1: I find it fun using contactless payment	0.71	3.10 (0.79)	0.86	0.61	0.73
	ENJ2: I enjoy using contactless payment in my daily life	0.77				
	ENJ3: It gives me satisfaction to make payments using contactless payments	0.85				
Status symbol	SS1: Contactless payments enhance my status	0.85	2.98 (0.85)	0.91	0.74	0.89
	SS2: Contactless payment makes me look professional	0.85				
	SS3: Contactless payment enhances my confidence	0.93				
	SS4: I find it cool to use contactless payment	0.81				
Innovativeness	I1: I am interested in keeping up with the latest digital payment application.	0.40	NR	NR	NR	NR
	I2: I am interested in using the latest digital payment application	0.53				
	I3: I don't mind trying a digital payment application that is new to the market	0.37				
Lack of awareness	LOA1: I don't know where I can use contactless payments	0.82	2.65 (0.97)	0.90	0.76	0.88
	LOA2: I am not aware of contactless payments available	0.86				
	LOA3: I don't know when I can use contactless payment	0.93				
Discomfort	DISC1: I find it tedious to always maintain my credit balance.	0.75	2.57 (0.98)	0.89	0.72	0.88
	DISC2: I find it tedious in setting up contactless payment	0.86				
	DISC3: I find it uncomfortable to carry my technology device around (e.g., laptop, smartphones)	0.94				
	DISC4: There are too many hassles in contactless payment (e.g., forgetting to carry around mobile phones, battery dead)	0.83				
Perceived Insecurity	PI1: I don't feel secure in using digital payment	0.59	NR	NR	NR	NR
	PI2: I am concerned about my online privacy	0.24				
	PI3: I feel uncomfortable as there have been too many security breaches lately.	0.57				
	PI4: I just don't trust any online payment mechanism	0.36				

Innovativeness and perceived Insecurity loadings are shown for clarification only; they were excluded from further analysis.
NR not relevant, *SD* standard deviation.

Table 3 Discriminant validity.

Factors	Perceived ease of use	Perceived usefulness	Optimism	Compatibility	Enjoyment	Status symbol	Lack of awareness	Discomfort
Perceived ease of use	**0.794**							
Perceived usefulness	0.788	**0.781**						
Optimism	0.731	0.760	**0.781**					
Compatibility	0.628	0.562	0.389	**0.755**				
Enjoyment	0.573	0.019	0.241	0.743	**0.781**			
Status symbol	0.218	0.175	0.211	0.721	0.758	**0.794**		
Lack of awareness	0.207	0.159	0.141	0.631	0.664	0.529	**0.872**	
Discomfort	0.145	0.132	0.101	0.466	0.384	0.219	0.862	**0.849**

symbol being an insignificant enabler is in line with the findings of Dhingra et al. (2020) but contradicts those of Sen (2020) and Rathika, Mitrapriya, 2018. This is probably because contactless payment methods are now widely accessible and not exclusive to a particular socioeconomic group. Unlike luxury items or expensive possessions that can symbolize status, contactless payments are commonly available to a broad range of people, making them a practical and ubiquitous financial tool rather than a status indicator. This holds particularly true in the post-pandemic landscape, where a multitude of businesses, ranging

from large retailers to micro-enterprises, actively embrace and accommodate contactless payment methods, especially in Malaysia. This may explain the insignificance of compatibility and optimism as well. The majority of our respondents are fairly young (i.e., below 50 years old), educated, and urbanites; hence they are fairly accustomed to using digital applications in their daily lives. Similarly, enjoyment was probably insignificant, as contactless payment methods are primarily valued for their convenience and efficiency in everyday transactions. Therefore, most adult users may perceive them as tools for practical utility rather than sources of entertainment, unlike other platforms, such as games and social media applications.

Finally, as stated in the section "Materials and methods", innovation (H7) and perceived insecurity (H10) were excluded from further analysis in this study due to very low factor loadings. The relatively low emphasis on these factors in contactless payment can be attributed to several factors, especially considering that a significant portion of our sample comprises young and tech-savvy individuals (section "Respondents"). Advances in security measures, such as robust encryption protocols and multi-factor authentication, have significantly enhanced the overall security of contactless payment platforms, thus instilling confidence among users. Further, the inherent convenience, speed, and efficiency offered by contactless payment methods tend to outweigh lingering security concerns for many users, particularly those who are adept at navigating technology.

Table 4 Goodness of fit indices.

Measure	Acceptable threshold	CPAM
χ^2/df	3.00–5.00	3.41
p-value	Less than 0.05	0.00
CFI	0.90–0.95	0.928
GFI	0.90–0.95	0.901
RMSEA	0.05–0.08	0.075
SRMR	<0.09	0.077

Conclusion, limitation, and future work

This study aimed to identify the enablers and disablers affecting users' acceptance of contactless payments among Malaysian adults. A Contactless Payment Acceptance Model based on factors identified from UTAUT 2 and TRI 2 and extended with other factors from the literature was developed. A total of 434 Malaysians between the ages of 18 and 64 were recruited using self-administered surveys. The results indicated that aspects such as the perceived ease of use, perceived usefulness, lack of awareness, and discomfort have significant direct effects on users' acceptance of contactless payments, with the model having an R-squared score of 71.2%.

Theoretical implications. This study contributes significantly to the theoretical understanding of factors influencing users' acceptance of contactless payments, particularly within the context of Malaysian adults. By integrating elements of UTAUT 2, TRI 2, and other factors from the literature, the model (i.e., CPAM) developed and validated in this study extends the existing theoretical frameworks to provide a more comprehensive understanding of the enablers and disablers influencing the acceptance of contactless payments. The incorporation of additional factors from the literature, particularly lack of awareness, which emerged as a significant disabler, also reflects a holistic approach to model development, in recognition of the multi-dimensional nature of user behavior in adopting contactless payment systems.

The findings also reveal specific facets that play a crucial role in shaping users' acceptance of contactless payments. Notably, perceived ease of use and perceived usefulness emerged as influential enablers, aligning with established theories in technology acceptance as well as prior studies (Lekmat, 2018; Mohamed et al., 2020; Faletehan et al., 2020; Hamid et al., 2016; Chawla and Joshi, 2020). This emphasizes the need for businesses and policymakers to prioritize the design of intuitive and convenient contactless payment solutions while highlighting their practical advantages. Such emphasis on ease of

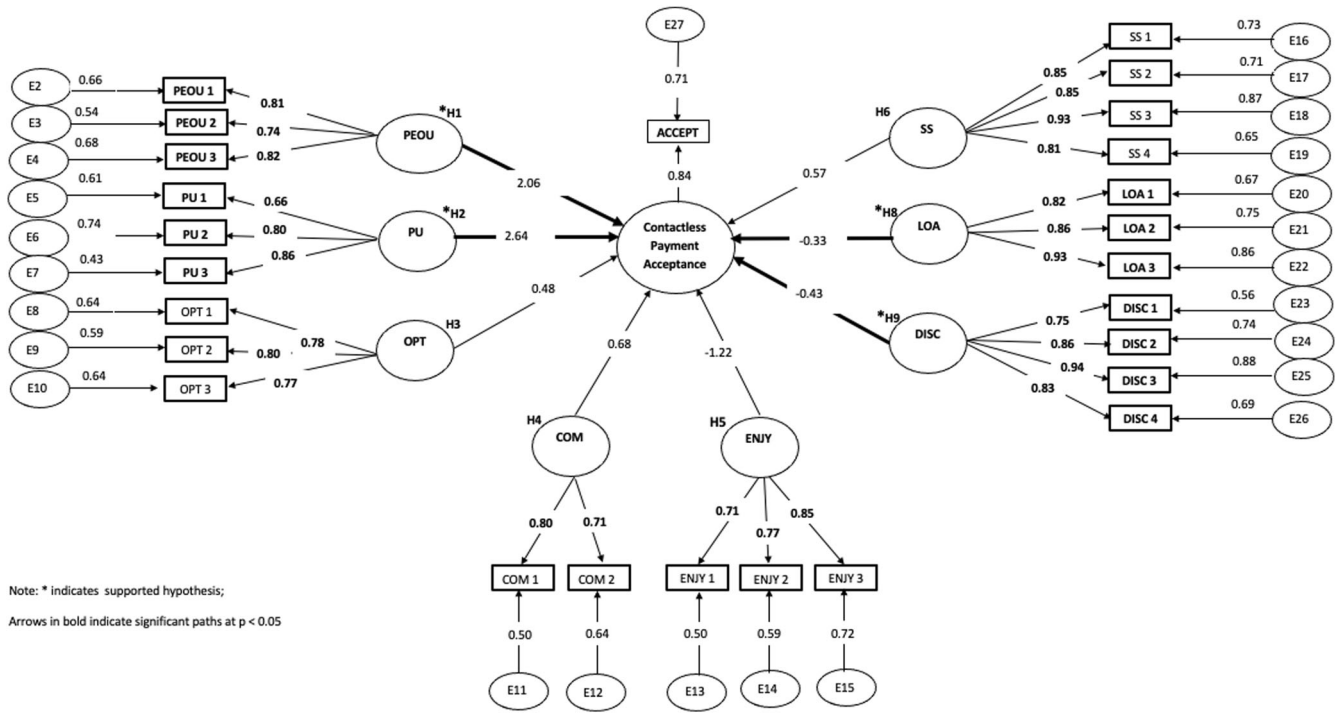

Fig. 2 Structured equation modeling results for CPAM. This figure shows all the varibles and their components used to assess the model.

Table 5 Hypotheses testing.

Hypotheses	Path	*p*-value	*t*-value	Remark
H1	PEOU → CPA	0.001*	3.750	Supported
H2	PU → CPA	0.001*	4.965	Supported
H3	OPT → CPA	0.288	1.063	Not Supported
H4	COM → CPA	0.416	0.813	Not Supported
H5	SS → CPA	0.158	-1.412	Not Supported
H6	ENJ → CPA	0.072	1.800	Not Supported
H8	LOA → CPA	0.008*	-2.649	Supported
H9	DISC → CPA	0.001*	-3.582	Supported

PEOU perceived ease of use, *PU* perceived use, *OPT* optimism, COM compatibility, *SS* status symbol, *ENJ* enjoyment, *LOA* lack of awareness, *DISC* discomfort.
*significant at $p < 0.05$.

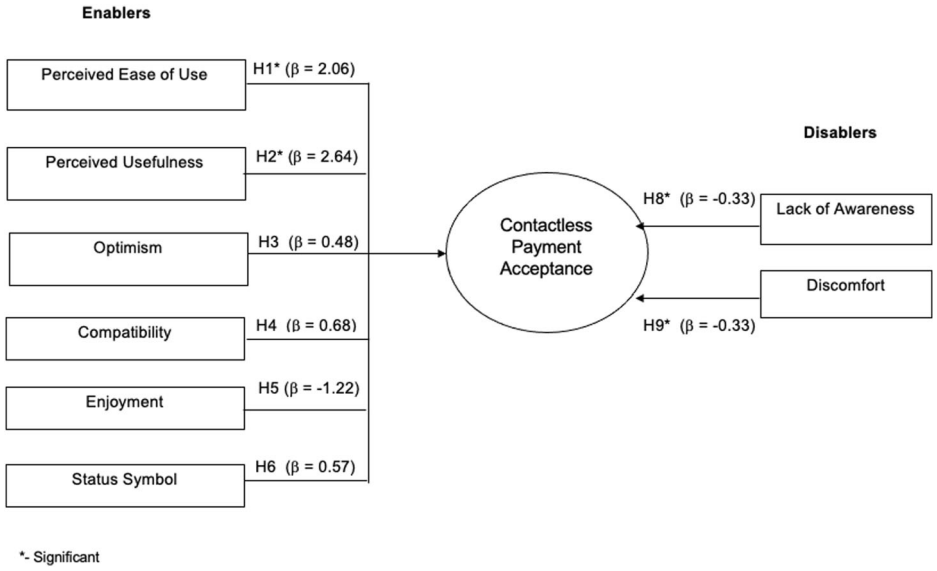

Fig. 3 Summary of CPAM analysis. This figure depicts the significant factors found affecting Contactless Payment Acceptance.

use and usefulness as key determinants of adoption sheds light on the intricate dynamics between technology adoption theories and real-world applications and offers valuable insights for future research and practical initiatives aimed at promoting the uptake of contactless payment systems in Malaysia and beyond. Furthermore, the identification of factors such as lack of awareness and discomfort highlights the nuanced nature of barriers to the adoption of contactless payment systems, in accordance with findings by other scholars (Semerikova, 2019; Aris et al., 2022; Al-Okaily et al., 2022). The emergence of lack of awareness as a significant disabler, for example, suggests that efforts to promote awareness and educate the public about the benefits and functionalities of contactless payments could greatly enhance their acceptance and use, particularly among Malaysian consumers.

The robust *R*-squared score of 71.2% suggests that CPAM, which was developed by integrating UTAUT 2, TRI 2, and factors from the literature, effectively captures a substantial portion of the variance in users' acceptance behavior of contactless payment systems. These theoretical implications contribute to refining existing models and offer valuable insights for researchers and practitioners seeking a deeper understanding of the dynamics surrounding contactless payment adoption among its users, particularly among adults.

Practical implications. The practical implications of the study hold valuable insights for various stakeholders involved in the promotion and implementation of contactless payment systems in Malaysia. First, the emphasis on perceived ease of use and perceived usefulness as significant enablers underscores the importance of designing user-friendly and functional contactless payment interfaces. Developers and service providers should prioritize intuitive designs and functionalities to enhance the overall user experience, ultimately fostering greater acceptance among Malaysian adults.

Additionally, addressing issues related to lack of awareness becomes imperative for successful implementation. Awareness campaigns and educational initiatives can play a pivotal role in informing the target demographic in Malaysia, including consumers, merchants, and policymakers, about the benefits and ease of use associated with contactless payment methods, thereby mitigating potential barriers to adoption. Stakeholders such as financial institutions, mobile network operators, government agencies, and industries can collaborate to implement these campaigns. For instance, financial institutions can lead by providing informational materials and hosting workshops to educate consumers and merchants about the security features and convenience of contactless payments, whereas mobile network operators can incorporate promotional materials into their

marketing strategies to reach a wider audience and encourage adoption. Through collaborative efforts involving various stakeholders, greater awareness and acceptance of contactless payments can be cultivated, thereby facilitating their seamless integration into everyday transactions.

Furthermore, the recognition of discomfort as a significant disabler influencing acceptance suggests the need for interventions that address users' apprehensions and concerns. Initiatives such as user training programs, transparent communication about security measures, and enhancing the visibility of the safety features of contactless payment systems can contribute to alleviating discomfort and building trust among potential users, especially among older users. As the model exhibits robust explanatory power, policymakers, financial institutions, and businesses can leverage these insights to tailor interventions and strategies that target the identified enablers and disablers. By aligning practical efforts with the theoretical findings, stakeholders can facilitate a smoother and more widespread adoption of contactless payments.

Limitations and future work. This study had several notable limitations that warrant consideration. First, a predominant portion of the respondents were from urban and educated backgrounds, hence potentially skewing the findings toward a specific demographic. This is probably due to the use of an online approach in data collection. Given that a cashless society encompasses a diverse population, future research endeavors should replicate the study design with a more inclusive approach. This could involve recruiting participants from various socio-economic strata, particularly those residing in smaller towns or possessing lower levels of education. Additionally, a greater representation of respondents from the low-income category should be sought, as low income is often a significant barrier to the adoption of contactless payment methods. Such inclusions could facilitate collaborations between the government and service providers to extend financial support to individuals in need through promotions or tailored packages. Further, future studies could include more users who are above 50 or 60 years old to ensure improved inclusivity in investigating contactless payment technologies.

Second, the utilization of self-administered questionnaires while practical, may introduce certain limitations. Respondents may be prone to social desirability bias, where they provide answers, they believe are socially acceptable rather than fully reflecting their true opinions or behaviors. This bias can result in inaccurate reporting and potentially skew the study's findings. Future research should explore alternative data collection methods or employ strategies to mitigate these biases for a more accurate representation of user perspectives and behaviors regarding contactless payment adoption. For example, qualitative data collection approaches, such as interviews, can be utilized to complement the quantitative approach. In-depth interviews can provide valuable insights into individuals' beliefs and experiences with contactless payments, allowing researchers to explore nuances and uncover underlying motivations that may not be captured through survey responses alone.

Finally, the study embraced a partial adaptation of UTAUT 2, aligning with the research focus and building upon previous studies. While this approach allowed for a targeted exploration of specific enablers and disablers, it is essential to acknowledge the exclusion of other factors, such as social influence, price, and habit. Our investigation of social influence concentrated on the dimension of status symbol (image). While our findings suggested its insignificance in this context, future research can delve more comprehensively into this factor as evidence exists regarding the effect of social influence on contactless payment adoption (Singh et al., 2020). Additionally, our findings demonstrated that factors such as status symbol, compatibility, enjoyment, and optimism were insignificant, whereas others such as perceived insecurity and innovativeness were excluded from the preliminary analysis. These findings contradicted some previous works; therefore, future research could further explore these enablers and disablers for a more conclusive investigation of the acceptance of contactless payment systems.

Data availability

The data will be made available based on a reasonable request.

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Author contributions

VB: conceptualization, drafting original manuscript, supervision; MJ: data collection, formal analysis, visualization.

Competing interests

The authors declare no competing interests.

Ethics approval

The questionnaire and methodology for this study were approved by the University of Malaya Ethics Committee [UM.TNC2/UMREC_2378]. The data collection was done in accordance with the research protocol and guidelines approved by the university.

Informed consent

All the respondents were informed that the data collected would be treated with the strictest confidentiality, and they were anonymized. Respondents were also informed that they had the decision to withdraw at any time.

Additional information

Supplementary information The online version contains supplementary material available at https://doi.org/10.1057/s41599-024-03057-7.

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