A game theory-based analysis of merchants' mobile payment adoption using hybrid SEM-neural network approach

Abstract

Purpose – This study is driven by the evidence from the literature on the significance of mobile (m-)payment in economic growth and productivity and at the same time the relative dismal adoption of this service. Drawing upon the game theory framework, the present study set out to elucidate the merchants' m-payment adoption from the perspective of trust in the Malaysian context.

Design/methodology/approach – An online survey consisting of 302 respondents was carried out to investigate the impact of trust and opportunism on merchants' perceived trustworthiness using a two-staged SEM-neural network approach to determine the significance and relative importance of variables. This study also applies a game-theoretic approach to analyze the impact of trust on the relationship between merchants and m-payment service providers

Findings – The results indicate a positive and statistically significant relationship between merchant trust, merchant opportunism and perceived trustworthiness; And a statistically significant negative relationship was found between m-payment provider opportunism and perceived trustworthiness. The findings from the prisoner's dilemma two-player model indicate that the scenarios of mutual trust and mutual opportunism as paradigmatic of cooperation and defection produce the best and worse outcomes respectively. An intriguing result was the positive impact of merchant opportunism on perceived trustworthiness which indicates a very calculative orientation of merchants in m-payment contracting.

Originality/value – To our knowledge, this is amongst the first attempts to propose a game theory approach to the interaction between merchants and m-payment providers under the framework of trust and opportunism. A game theory study in the context of mobile payment adoption can contribute to the theoretical literature by providing insights into the decision-making processes of merchants. By incorporating trust and opportunism into the game theory model, we can gain a better understanding of how they affect the decision-making process and overall adoption rates. The conclusions and implications provide useful insights for managers of both m-payment platforms and merchants in this relational exchange. The results of the present research can provide insights into the factors that influence merchant decisions and guide them towards suitable partnerships for successful adoption and can guide authorities for policy interventions and supporting adoption efforts.

Keywords: Mobile payment, merchants' perspective, trust, opportunism, Malaysia

Article classification Empirical research paper

JEL: G23, G41

Introduction

The current advances in technology are giving rise to a new generation of payment systems known as mobile (m-)payment which offers interesting and advantageous services compared to traditional modes of payment. Apart from health and security benefits, m-payments offer convenience by allowing users to avoid cash (Pham & Ho, 2015), lower service costs and better user experience (Apanasevic & Arvidsson, 2016), provided by new technological enablers such as Quick Response (QR) code, wearables and various

applications (Capgemini, 2016). Therefore, the attractiveness of m-payment services for customers brings about a competitive advantage for merchants and electronic commerce organizations (Kim et al., 2010) followed by improved sales and customer services (Mallat & Tuunainen, 2008). Furthermore, the development of m-payment services is one of the key factors in economic growth through the enhancement of financial inclusion and providing payment services for small and medium-sized enterprises (SMEs) (Yeboah et al., 2020). However, after almost two decades of the first mobile transaction, the adoption amongst customers and merchants remains low which calls for more scrutiny (Moghavvemi et al., 2021).

Through a comprehensive review of the literature, we identify three main gaps related to the topic under study. First, the contextual gap: he literature on m-payment adoption hosts a myriad of studies probing its drivers and barriers (exp. Apanasevic & Arvidsson, 2016; Johnson et al., 2018; Mallat & Tuunainen, 2008; Sharma et al., 2019; Singh et al., 2020a; Williams, 2021), but they have, for the most part, focused on the behavioral intention of 'users' to adopt m-payment and very few attempts explored merchants' perspective which is an essential element in fully understanding this phenomenon (Yeboah et al., 2020), considering the fact that the success of m-payment is heavily dependent on the extensive adoption by merchants (Singh & Sinha, 2020). Another contextual gap relates to vendor selection and partnership. Merchants may face challenges in selecting the right mobile payment solution provider and establishing partnerships with relevant stakeholders. However, research on the decision-making processes, criteria, and challenges involved in selecting mobile payment vendors and forming partnerships with financial institutions or technology companies is limited. Additionally, the stage of market maturity for mobile payment solutions can significantly impact adoption, and various studies reported the impact of governance, culture and macroeconomic characteristics on firm strategies and decision-making processes (Al-Bakri et al., 2014; Al Momani et al., 2021; Nour et al., 2020; Jabarin et al., 2019; Asa'd et al., 2022; Najjar et al., 2023). Existing studies have predominantly focused on markets with relatively high mobile payment penetration, such as China and certain European countries. Research is needed to explore the adoption challenges faced by merchants in emerging markets or regions with slower adoption rates.

Second, the theoretical gap: variety of theories have been the basis of m-payment adoption literature, unearthing factors such as economic benefits, trialability, social approval, and visibility using the theory of diffusion of innovation (DOI) (Apanasevic & Arvidsson, 2016; Johnson et al., 2018; Kapoor et al., 2015; Shao et al., 2019), tradition barriers and value barriers using innovation resistance theory (Kaur et al., 2020; Leong et al., 2020), perceived security, perceived benefits and perceived risk using perceived risk theory (Barkhordari et al., 2017; de Kerviler et al., 2016; Yang et al., 2015), perceived ease of use, perceived usefulness and perceived trust using technology acceptance model (TAM) (Pu et al., 2020; Sharma et al., 2019; Singh et al., 2020; Williams, 2021) and finally effort expectancy and performance expectancy using unified theory of acceptance and use of technology (UTAUT) (Cao & Niu, 2019; Chaiyasoonthorn, 2019; Hussain et al., 2019; Teo et al., 2015). However, a comprehensive review of the literature points to 'trust' as one of the main factors which drastically influences the intention to use and is a significant facilitator in m-payment services (exp. Dahlberg et al., 2015; Liébana-Cabanillas & Lara-Rubio, 2017; Mallat & Tuunainen, 2008; Moghavvemi et al., 2021; Nguyen et al., 2020; Yeboah et al., 2020). Trust can be defined as "the expectation held by the customer that the service provider [i.e., the m-payment] is dependable and can be relied on to deliver on its promises" (Sirdeshmukh et al., 2002), and is regarded as one of the most crucial elements in developing and maintaining an efficient and well-operated business relationship particularly in the financial services industry (Hansen, 2012). Nevertheless, empirical evidence regarding the role of trust as an essential enabler in the relationship between merchants and m-payment providers remains scarce. Furthermore, in the extant literature trust is mostly regarded as a single and one-sided concept, while it is important to investigate its various dimensions (Nguyen et al., 2020). Therefore, considering the dyadic nature of trust (Dahlstrom et al., 2014) and the fact that when trust erodes, it may trigger opportunism which holds true for both sides of the relationship including merchants and m-payment providers, this research is a preliminary analysis to elucidate how these scenarios in either side of the relationship influence the outcome; this is based on the premise that situations of trust are a subclass of those involving risk and that the risk taken by one party depends on the performance of the other party (Williamson, 1993). No

research has yet examined this dyadic relationship in the context of m-payment which is an important shortcoming.

Third, the methodological gap: given the linear nature and potential oversimplification of conventional statistical techniques like regression analysis and SEM (Liébana-Cabanillas & Lara-Rubio, 2017), the use of Artificial Neural Networks has been recommended due to its robustness, adaptability, and ability to identify non-linear relationships (Aryadoust & Goh, 2014). However, machine learning techniques are often considered "black box" models, lacking insight into their structure, and are not ideal for investigating causal relationships and hypothesis testing (Liébana-Cabanillas et al., 2018). Therefore, to address these limitations, a hybrid two-stage approach is employed in this study, as suggested in the literature (e.g., Ahani et al., 2017; Chong, 2013; Liébana-Cabanillas et al., 2018; Sharma et al., 2019).

Additionally, according to the World Bank, although 85% of the population in Malaysia have bank accounts and thus, have access to traditional financial services, only 55% receive their wages through bank accounts and only 34% use their bank account for savings (Luna Martinez, 2017). As indicated in the Global Findex Report (Demirguc-Kunt et al., 2018), while 41% of adults in Malaysia own debit cards, only 19% use them in their transactions. A recent study (Loo, 2019) supports this, reporting that more than 40% of working adults in Malaysia still receive their salary in cash. Moreover, because of the extensive use of mobile internet in the country (93.5 percent of the population according to Statista (2021)), the increasing number of e-money providers (50 as of 2023), licensing of digital banks in 2022, and several government initiatives toward digitalization (exp. Interoperable Credit Transfer Framework (ICTF)[1] and eBelia[2] program), Malaysia is an ideal setting to analyze mobile payment adoption. Despite the efforts by authorities in Malaysia to promote m-payment, a considerable volume of transactions is still carried out using cash (approximately 80 percent according to Moghavvemi et al. (2021)). In the meantime, Guo and Bouman (2016) emphasize that the users' as well and merchants' adoption are mutually dependent and m-payment should be used by both parties to create network externalities and critical mass. However, the causes of the lag in m-payment adoption in Malaysia are yet to be fully investigated.

To address this and as a response to the call to go beyond the traditional models of technology adoption in the m-payment literature (Rouibah et al., 2016) and to expound on the interplay between the common and conflicting interests of two players, we, therefore, apply a game-theoretic approach to analyze the impact of trust on the relationship between merchants and m-payment service providers. By doing so, the present research addresses the existing need in the literature for a deeper understanding of merchants' motivations, by investigating the underlying psychological driver (focusing on trust) that shapes merchants' perceptions and attitudes. This can contribute to a more nuanced understanding of merchants' m-payment adoption, provide practical insights for stakeholders and policymakers by signifying the importance of trust as an influential factor in promoting and maintaining development and stability in the m-payment industry and fostering effective strategies to alleviate the hurdles.

The remainder of the paper is organized as follows. First, the review of related literature and theoretical background is introduced followed by a review of the methods. Next, the results are presented. Finally, the implications of the findings are discussed and suggestions for future research are provided.

Review of related literature

Mobile payments have become increasingly popular in recent years, offering a quick and convenient alternative to traditional payment methods such as credit cards and cash. While many consumers have already adopted mobile payment technologies, the adoption of mobile payments by merchants has been

[1] https://www.bnm.gov.my/-/interoperable-credit-transfer-framework-ictf-3

[2] The e-Belia program was initiated by the ministry of finance and announced under budget 2021 to allocate RM200 million e-Wallet credit to eligible Malaysian youth and was primarily aimed at promoting cashless payment and the use of m-payment

slower and more nuanced. The use of mobile payments by merchants has become increasingly popular in recent years, and several studies have explored the factors that influence their adoption.

One of the first factors that has been explored is the perceived usefulness of mobile payments. This refers to the extent to which merchants believe that mobile payments are a beneficial tool for their businesses. Studies have found that merchants who perceive greater usefulness are more likely to adopt mobile payments (Liébana-Cabanillas & Lara-Rubio, 2017; Moghavvemi et al., 2021). However, the perceived usefulness of mobile payments may be subject to a variety of other factors. For instance, studies indicate that perceived usefulness can be influenced by the ease of use of mobile payments (Moghavvemi et al., 2021; Gupta et al., 2022), the availability of alternative payment methods such as cash or credit cards (Gupta et al., 2022), and the adoption of a particular mobile payment technology by customers (Liébana-Cabanillas & Lara-Rubio, 2017). Therefore, merchants might be more likely to adopt a particular mobile payment if it integrates seamlessly with their existing payment methods and customer behavior.

Another important factor that has been explored in the literature is perceived security. Merchants who perceive greater security risks associated with mobile payments may be less likely to adopt them (Liébana-Cabanillas & Lara-Rubio, 2017; Gupta et al., 2022). Security concerns may include potential fraud, unauthorized access to customer data, or the inability to manage chargebacks. To overcome these concerns, merchants may require more education or reassurance on the reliability of mobile payment providers.

In addition to perceived usefulness and perceived security, several other factors have been identified in the literature as being relevant to mobile payment adoption by merchants. For instance, the cost of transaction fees associated with mobile payments can be a significant factor in adoption (Mallat and Tuunainen, 2008; Mallat and Tuunainen, 2005). High transaction fees could discourage merchants from integrating mobile payments alongside other payment methods. Similarly, the level of technological sophistication of merchants has also been found to be a factor in mobile payment as highlighted by Gupta et al. (2022).

The willingness of consumers to adopt mobile payments has been shown to have an impact on merchant adoption (Pidugu, 2015). If consumers are increasingly using mobile payments, merchants may feel pressure to adopt them to remain competitive. Additionally, merchants may use consumer demand as a signal for the benefits of mobile payments, and be more likely to adopt them.

The ease of integration of mobile payment technologies has been identified as a factor in adoption. Merchants may be more likely to adopt a mobile payment technology if it integrates easily with their existing point-of-sale systems (Gupta et al., 2022). A technology that is difficult to integrate or requires significant changes to existing systems may be less appealing to merchants.

The regulatory environment has been identified as a potentially important factor in mobile payment adoption by merchants. Regulations could impact the cost of transactions, the security of customer data, or other aspects of mobile payment adoption (Mishra et al., 2022). Uncertainty or instability in the regulatory environment could discourage merchants from adopting mobile payments. Additionally, Yeboah et al. (2019) indicate that business model and the nature of business, contextual factors and technology type, as well as cost and competition, are the main drivers (inhibitors) for adoption amongst merchants.

However, a comprehensive review of the literature points to 'trust' as one of the main factors which drastically influences the intention to use and is a significant facilitator in m-payment services (exp. Dahlberg et al., 2015; Liébana-Cabanillas & Lara-Rubio, 2017; Mallat & Tuunainen, 2008; Moghavvemi et al., 2021; Nguyen et al., 2020; Yeboah et al., 2020)

Theoretical background

It is well established in the literature that trust is a fundamental element of the social fabric and economic transactions and it is suggested that financial contracts specifically require a high level of trust (Carbo-Valverde et al., 2013). Many studies have analyzed the impact of trust on various financial and economic growth factors for instance Guiso et al. (2000) highlighted the effect of trust on access to credit, use of checks and more investments among households, Hedayati and Rahman Seresht (2019) indicated the positive and significant effect of trust on the likelihood of making deposits in public and private financial institutions, Xu (2020) posited that social trust remains a significant determinant for various aspects of financial inclusion and Baidoo and Akoto (2019) found a positive relationship between trust and the likelihood of saving in financial institutions. However, considering the central role of trust in financial transactions it is predominantly treated in the literature as a single-dimensional factor with disregard to the rectitude of the agents involved in the transaction and the element of opportunism.

The growing body of literature on interfirm relationships is shaped by the polar perspectives of 'economic man' (emphasizing rational cost-benefit calculative approach) and 'heroic man' (emphasizing the non-rational and non-calculative nature of humans) (Lado et al., 2008). This has led to the emergence of two predominant theories in the field i.e., transaction cost economics theory (exp. Williamson, 1993) which following the economic man assumption, posits that the general behavior of parties involved in economic transactions is influenced by opportunistic tendencies with the ultimate goal of minimizing the transaction cost and on the other hand, relational exchange theory is built upon the heroic man assumption (exp. Heide & John, 1992) and considers trust as the main fostering element in the economic transactions. While each of these frameworks is regarded as a critical basis for understanding behavioral intentions in interfirm relationships, there is a compelling rationale for adopting a more tempered view of human nature (Lado et al., 2008) in the context of present research and include both extreme sides of the spectrum in order to have a more holistic and broader perspective on the relationship between merchants and m-payment providers characterized by varying levels of trust and opportunism in light of the fact that the concept of trust is difficult to disentangle from opportunism (Elsharnouby & Parsons, 2013), and that trust and opportunism are the main underlying tendencies in a dyadic relationship (Wathne & Heide, 2000). However, the relationship between trust and opportunism is not always elucidated in this manner in the literature.

Trust lends its necessity to the presence of the risk of opportunism (Chiles & McMackin, 1996). The risk of opportunism entails expropriation of benefits by participants in a relationship (Dahlstrom, 2014) and could include overt behaviors such as lying, cheating, and stealing or more subtle forms such as dishonoring the contract, shirking and failing to fulfill promises and obligations (Jap, 2001). Both m-payment providers and merchants can pursue self-interest-seeking behavior by breaching and manipulating the agreements to lower their costs and gain higher profit which can diminish trust and lead to unfavorable results for both sides. This possibility of following different choices and courses of action yielding varied outcomes, therefore, can be analyzed in the context of a "prisoners' dilemma" game in a game-theoretic approach.

Game theory

Game theory is both a conceptual and mathematical instrument to analyze the interaction between players with common and conflicting interests, therefore, it is a suitable toolkit for elucidating trust-related issues (Witteloostuijn, 2003). It assumes that parties in a relationship behave strategically to maximize their interest (Peters, 2015). One of the most prominent models of strategic games is the prisoner's dilemma. It gets its name from the hypothetical situation where two convicts under police interrogation are faced with the dilemma of either testifying against their partner (defect) or keeping quiet and asking for a lawyer (cooperation with the partner) without any knowledge about each other's decisions (Dixit & Skeath, 2015). This model can be used to describe different economic situations including merchants and m-payment providers relationships. When merchants choose to use m-payment solutions from a particular service provider, they hope to improve their customer service and maximize sales (Mallat & Tuunainen, 2008). In a similar vein, m-payment providers are primarily motivated to acquire contracts with merchants and expand their share in the very competitive market of financial technology (Bu et al., 2021). However, as

research has shown the risk of opportunism is an inevitable factor which in the context of the present research, for both sides include, payment system compromise, data connectivity compromise, token service compromise, denial of service, payment authorization process compromise, and breach of sensitive data (Sachovà et al., 2016). Subsequently, the interplay of trust and opportunism can be illustrated in a pay-off matrix as presented in Table 1. R_M and R_P represent the reward for mutual cooperation, T_M and T_P represent temptation for defection for merchant and m-payment provider, P_M and P_P represent punishment for mutual defection, and, S_P and S_M represent suckers payoff which is the gain the one party who follows opportunistic decision while the other party trusts.

Table 1. General pay-off matrix for a two-player game

m-payment provider / *Merchant*	Cooperation	Defection
Cooperation	R_M, R_P	S_M, T_P
Defection	T_M, S_P	P_M, P_P

In the prisoner's dilemma model, there are two categories of theories that have been offered to explain the players' strategies i.e., one-shot games (Harrington, 1995) which normally leads to mutual defection, and repeated games (Kreps, 1990). The latter applies to the context of present research and postulates that incomplete information regarding the partner's strategy plays a significant role in the finitely repeated games and that relying on the repeated nature of the game, there is a strong tendency to hold a belief that the partner is a cooperative player which induces even the self-interest seeking player to choose the cooperation strategy (Cooper et al., 1996). It should be noted that in the game theory model, the assumption of rationality of players is one of the key factors and imply that decisions are made after accounting for all alternatives to optimize the utility function (Dahlstrom et al., 2014). Experimental evidence on the prisoner's dilemma games as stated above, repeatedly show that some participants choose the cooperation strategy (Cooper et al., 1996), particularly in the case of merchant and m-payment provider, if one partner defects, the other will never trust, therefore the strong likelihood of dealing with the same partner in the future is a major contribution to the selection of cooperation strategy and reducing the chance of cheating (Dahlstrom et al., 2014). Some examples of cooperation and defect (lack of cooperation) scenarios are presented in Table 2.

Table 2. Cooperation and defect scenarios [3]

Payment service provider	Merchant
Provision of accurate financial and non-financial company information	Timely and complete fund settlement
Legitimacy of business and transactions	Issues related to fees and hidden charges
Compliance with applicable regulations on data security and data protection	Compliance with applicable regulations on data security and data protection
Business continuity and ability to pay the fees and chargeables	Quality of services and technical support
Safety, reliability and availability of their system and network infrastructure	Safety, reliability and availability of their system and network infrastructure
	Tolerable downtime

[3] Source: https://www.bnm.gov.my/-/PD_Merchant+Acquiring+Services+.pdf/

However, in reality, the choice of optimal strategy might be more complex as the strategies chosen by each player are unknown to other players. In the case of our research, mutual trust will lead to both players abiding by the agreement and gaining their profit. In case of opportunistic behavior and lack of trust by both merchants and m-payment providers, the gain will be smaller for both. If the merchant trusts but the m-payment provider proceeds with opportunistic behavior, the provider gains higher profit. In contrast, if the service provider trusts and the merchant chooses to act opportunistically, the service provider will gain less profit. The empirical illustration of these strategies and their outcomes is presented in the following sections.

Model

In the m-payment context, the risk of falling into the prisoner's dilemma situation depends on trust and opportunism on both sides of the relationship. The model for this study is adapted from Dahlstrom et al. (2014) with necessary adjustments and is formulated as:

$$\text{Perceived Trustworthiness} = \alpha + \beta_1 T_M + \beta_2 T_P + \beta_3 O_M + \beta_4 O_P + \varepsilon \quad (1)$$

where T_M is the merchant trust in the m-payment provider; T_P is the merchants' concept of how the m-payment provider trusts them; O_M is the merchant opportunism; O_P is the merchants' concept of the m-payment provider opportunism; ε the error term; α the constant term.

In order to analyze the interaction between variables, which is essential in explaining the overall outcome, the following model is constructed based on the assumption that all variables are interdependent and influence each other:

$$\text{Perceived Trustworthiness} = \alpha + \beta_1 T_M + \beta_2 T_P + \beta_3 O_M + \beta_4 O_P + \beta_5 O_P O_M + \beta_6 T_M T_P + \beta_7 T_M O_P + \beta_8 T_P O_M + \varepsilon \quad (2)$$

Method

In order to examine the dyadic relationship between merchants and m-payment providers, we proceeded with primary data collection through a questionnaire survey. For the purpose of data collection, this research adopts a convenience sampling approach. While probability sampling is known to provide a better representation of the population which in turn facilitates the generalization of results, due to difficulties related to accessing an exhaustive list of merchants and their contact information, convenience sampling was found to be a more practical and relevant method, facilitating the data collection process at a lesser cost. The target population of this study includes Malaysian merchants using m-payment services provided by e-money issuers. For this purpose, the publicly disclosed information about merchants was collected from the m-payment providers' websites accessed via The Financial Sector Participants Directory[4], provided by Bank Negara Malaysia (Central Bank of Malaysia); subsequently, the contact information of merchants was retrieved from their website, and initially, 600 emails were sent using Google forms[5], out of which 302 completed questionnaires were received that yields the response rate of 50.3 percent. There were 43.7 percent female and 56.29 percent male participants with more than half of them having at least a bachelor's degree. The majority of respondents were Chinese (70.79 percent) followed by Malay (16.83 percent), Indian (10.89 percent), and the rest other Malaysian race and expatriates. The survey included 22 questions using a 7-point Likert scale to measure the research's five factors. Our measurement items were based on the research by Dahlstrom et al. (2014), and modified accordingly to fit the context of this research. The obtained data were converted into a .csv file and, the analysis was carried out using IBM® SPSS® AMOS version 26.

[4] https://www.bnm.gov.my/list-of-regulatees

[5] In order to ensure compliance with ethical considerations, the opening page of the survey laid out statements regarding the voluntary nature of participation, the researcher's contact details, assurance regarding the confidentiality and privacy of responses and also the respondent's right to withdrawal or omission of survey items.

Results

Validation of measurement

Confirmatory factor analysis (CFA) was conducted on the five latent variables with each question (indicator) specified to load on pre-determined factors. A Maximum Likelihood (ML) estimate was conducted using the pool of sample of respondents. The CFA results are presented in Table 3.

Table 3. Confirmatory factor analysis

Construct/indicator	St. factor loadings	p-value	Critical ratio	Composite reliability
Merchant trust				0.84
X1	0.453	_	_	
X2	0.783	***	7.74	
X3	0.793	***	7.77	
X4	0.775	***	7.71	
X5	0.766	***	7.68	
M-Payment provider trust				0.88
X6	0.7	_	_	
X7	0.788	***	12.71	
X8	0.803	***	12.93	
X9	0.773	***	12.49	
X10	0.769	***	12.42	
M-Payment provider opportunism				0.91
X11	0.879	_	_	
X12	0.769	***	16.43	
X13	0.842	***	19.20	
X14	0.761	***	16.18	
Merchant opportunism				0.89
X15	0.854	_	_	
X16	0.842	***	18.47	
X17	0.855	***	19.00	
X18	0.807	***	17.24	
Perceived trustworthiness				0.83
X19	0.768	_	_	
X20	0.754	***	12.97	
X21	0.662	***	11.27	
X22	0.787	***	13.58	

Table 4. Goodness-of-fit statistics

Variable	CMIN	DF	RMSEA	CFI	TLI	NFI	Sig.
Measurement model	416.69	199	0.60	0.948	0.934	0.907	< 0.01

Although the measurement model yields a chi-square of 416.69 ($df = 199$, $p < .01$) (Table 4), it is suggested in the literature that the lack of absolute fit can be explained by the high sensitivity of CMIN to the sample size (Meyers et al., 2005); therefore, to obtain a more accurate evaluation of model fit, other measures are employed which in our case, the root mean square error of approximation (RMSEA = .060), comparative fit index (CFI = .948), Tucker-Lewis index (TLI = .934) and normed fit index (NFI = .907) all indicate that

the model is parsimonious since the values are close to .90 (Bentler, 1990; Bentler & Bonett, 1980; Hu & Bentler, 1999; Meyers et al., 2005). Examination of composite reliability is useful to take a closer look at parameter estimates and verify the significance and proper direction of coefficients (Bagozzi & Yi, 1988). Composite reliability was calculated as:

$$CR = \frac{(\sum \lambda_i)^2}{(\sum \lambda_i)^2 + (\sum \varepsilon_i)} \quad (3)$$

Whereby, λ (lambda) is the standardized factor loading for item i and ε is the respective error variance for item i. The error variance (ε) is estimated based on the value of the standardized loading (λ) as:

$$\varepsilon_i = 1 - \lambda_i^2 \quad (4)$$

As can be seen in Table 3, the composite reliabilities for the five factors were all close to or greater than .80 which suggests good reliability of measured constructs (Bagozzi & Yi, 1988).

Descriptive statistics of the latent constructs

The mean value of four latent variables ranged from 4.952 to 5.515 with the standard deviation ranging from .991 to 1.522 on a seven-point Likert scale. Overall, the mean values for all of the latent variables were well above the midpoint of 3.5. Perceived trustworthiness scored highest with a mean value of 5.515 while merchant opportunism scored the lowest mean value of 4.952. Table 5 summarizes the descriptive statistics of latent variables.

Table 5. Descriptive statistics of variables

Variable	Mean	Std. Deviation
Merchant trust	5.380	1.000
M-Payment provider trust	5.502	1.011
M-Payment provider opportunism	5.117	1.384
Merchant opportunism	4.952	1.522
Perceived trustworthiness	5.515	0.991
Valid N (listwise)	302	

Structural equation modeling

The SEM method was used to examine the model in this study (Fig. 1). Table 5 provides a statistical summary of the SEM analysis of the theoretical model. The results of SEM analysis show that the R^2 value for the perceived trustworthiness is .756 which exceeds the substantial score threshold (Ahani et al., 2017). This indicates that 75 percent of the variations in perceived trustworthiness can be explained by the predictor variables in the model. The estimates of the constructs represent the standardized regression coefficients. The results indicate a positive and statistically significant relationship between merchant trust ($\beta = .548$, $p < .01$), merchant opportunism ($\beta = .654$, $p < .01$), and perceived trustworthiness. Furthermore, the results show a nonsignificant relationship between m-payment provider trustworthiness ($\beta = .268$, $p > .01$) and perceived trustworthiness. Finally, a statistically significant negative relationship was found between m-payment provider opportunism and perceived trustworthiness.

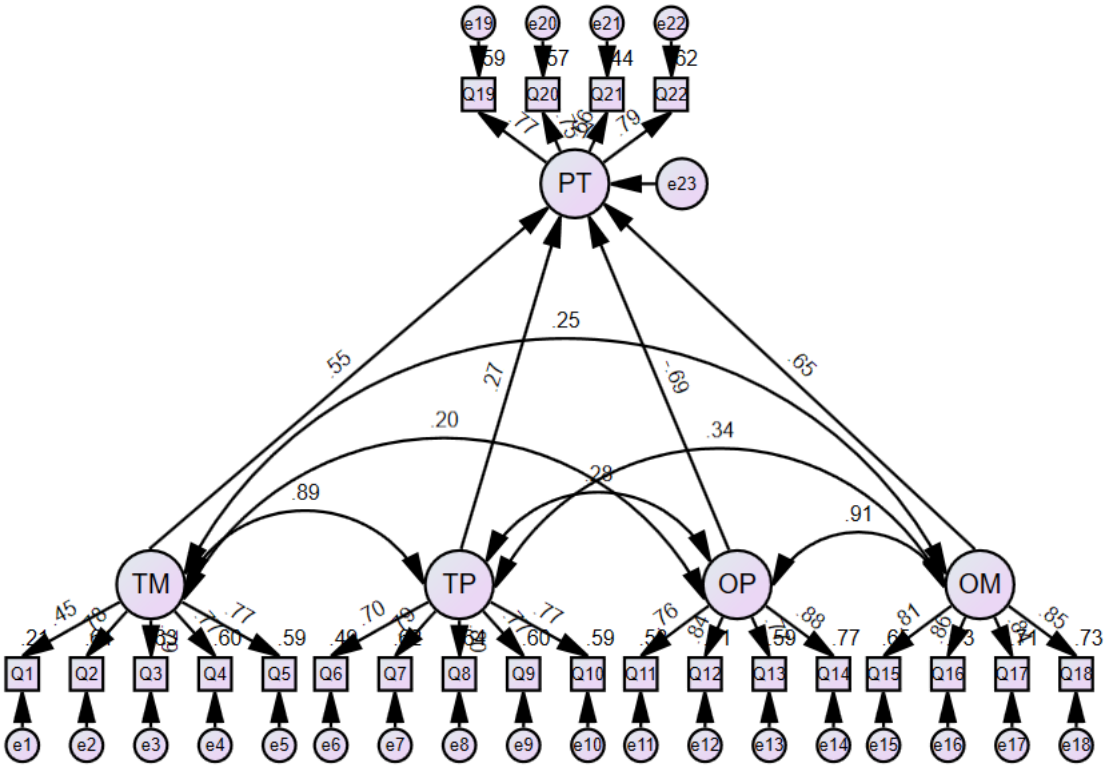

Fig 1. Structural model

Table 6. Summary of structural model results

Variables			Estimate	S.E.	C.R.	P
PT	<---	TM	0.548	0.168	3.549	***
PT	<---	TP	0.267	0.156	1.708	0.088
PT	<---	OP	-0.686	0.114	-3.986	***
PT	<---	OM	0.654	0.111	3.703	***
Interaction effects						
TM	<-->	TP	0.888	0.08	8.753	***
OM	<-->	OP	0.909	0.187	10.019	***
TM	<-->	OP	0.205	0.08	3.041	0.002
OM	<-->	TP	0.342	0.096	4.881	***

Note: *** $p < 0.001$

The results of interaction effects between the independent variables as presented in Table 6 shows a positive and statistically significant relationship between merchant trust and m-payment provider trust (β = .704, $p < .01$), merchant opportunism and m-payment provider opportunism (β = 1.872, $p < .01$), merchant trust and m-payment provider opportunism (β = .244, $p < .01$), merchant opportunism and m-payment provider trust (β = .469, $p < .01$). This is in line with the findings of Barkhordari et al. (2017), Kaur et al. (2020), Shao et al. (2019) and Sharma et al. (2019) who confirm the significant role of trust on m-payment technology adoption in the context of consumers; also related studies in the context of

merchants' adoption such as Moghavvemi et al. (2021) who indicated the importance of trust (more particularly data protection and service downtime), Singh and Sinha (2020) who found the mediating effect of perceived trust on the influence of usefulness and merchants' intention to use m-payment, Yeboah et al. (2020) who demonstrate the critical role of merchant trust in m-payment adoption and also elaborate on the role of service provider characteristics and mobile technology characteristics as imperative factors towards trust building, and finally similar recent results obtained by Gupta et al (2022) and Misha et al. (2022). Since perceived opportunism is a relatively understudied concept in the m-payment adoption literature, no previous studies were found to adopt this concept in the concept of merchants' m-payment adoption; however, we found few papers that integrated the opportunism in their framework in the context of customer m-payment adoption. For instance, Xin et al. (2015) indicated that perceived opportunism may not significantly influence m-payment adoption, however, they add that this might be due to the strong confidence of New Zealand consumers in the regulation and legal system in the country. Chandra et al. (2010) report a negative and significant influence of perceived opportunism in the case of non-users. And finally, Yeboah et al. (2020), through their descriptive case study and interviews with two merchants in the health industry, found that merchant perception of mobile payment providers' opportunism can reduce the level of their trust in mobile payment.

Artificial neural networks

Due to the linear nature of conventional statistical techniques such as regression analysis and SEM and the potential for oversimplification of results (Liébana-Cabanillas & Lara-Rubio, 2017), the application of ANN has been suggested on account of its robustness, adaptability, and ability to identify non-linear relationships (Aryadoust & Goh, 2014). However, machine learning techniques are still considered "black box" models (lack of insight into their structure) and are not suitable for examining causal relationships and hypothesis testing (Liébana-Cabanillas et al., 2018); therefore, a hybrid two-stage approach is used in the present research, as suggested in the literature (exp. Ahani et al., 2017; Chong, 2013; Liébana-Cabanillas et al., 2018; Sharma et al., 2019), where SEM is carried out in the first stage to identify the statistically significant predictors and then ANN is implemented in the second stage to quantify the importance of each variable in predicting the perceived trustworthiness.

This study developed a neural network model in the statistical software SPSS 26. In order to arrive at an index for each construct being measured, the composite scores were computed using the set of items for each factor in SPSS. The predictors were given as inputs to the neural network model. The ANN model comprised four input variables (merchant trust, m-payment provider trust, merchant opportunism, and m-payment opportunism) and one output variable (perceived trustworthiness). Out of 302 items, 211 (70 percent) were used to train the network, and 91 (30 percent) were used to test the network. Table 7 presents the weight indices of the input and output variables.

Table 7. Weight indices of the input and output variables of the neural network

	Predicted

Predictor		Hidden Layer 1			Output Layer
		$H_{(1:1)}$	$H_{(1:2)}$	$H_{(1:3)}$	PT
Input Layer	(Bias)	0.339	-0.323	-0.787	
	TM	1.268	0.518	-1.403	
	TP	2.052	0.562	-1.398	
	OP	-0.013	-0.129	0.597	
	OM	0.827	0.656	0.038	
Hidden Layer 1	(Bias)				1.374
	$H_{(1:1)}$				-0.595
	$H_{(1:2)}$				1.184
	$H_{(1:3)}$				-1.651

In contrast to the β coefficient in regression models, the ANN weight statistics have intra-variable variations (Aryadoust & Goh, 2014). As presented in Table 7, the weights of TM across three neurons in the hidden layer, notated as $H_{(1:1-3)}$, are 1.268, .518, and -1.403 indicating some degree of non-linearity in the data. There is also relatively high intra-variable variance in the next two inputs of TP (2.052, .562, and -1.398) and OP (-.013, -.129, and .597) indicating high non-linearity between these variables and PT. By contrast, intra-variable variance is relatively low in OM (.827, .656, and .038) indicating some degree of linearity between this variable and perceived trustworthiness. Table 7 also presents bias statistics for hidden and output layers. Bias helps the network to learn the underlying patterns of data in a more structured manner (Aryadoust & Goh, 2014). The bias coefficients for the neurons in the hidden layer are .339, -.323 -.787 showing a low degree of variance. The bias coefficient for the output layer is 1.374.

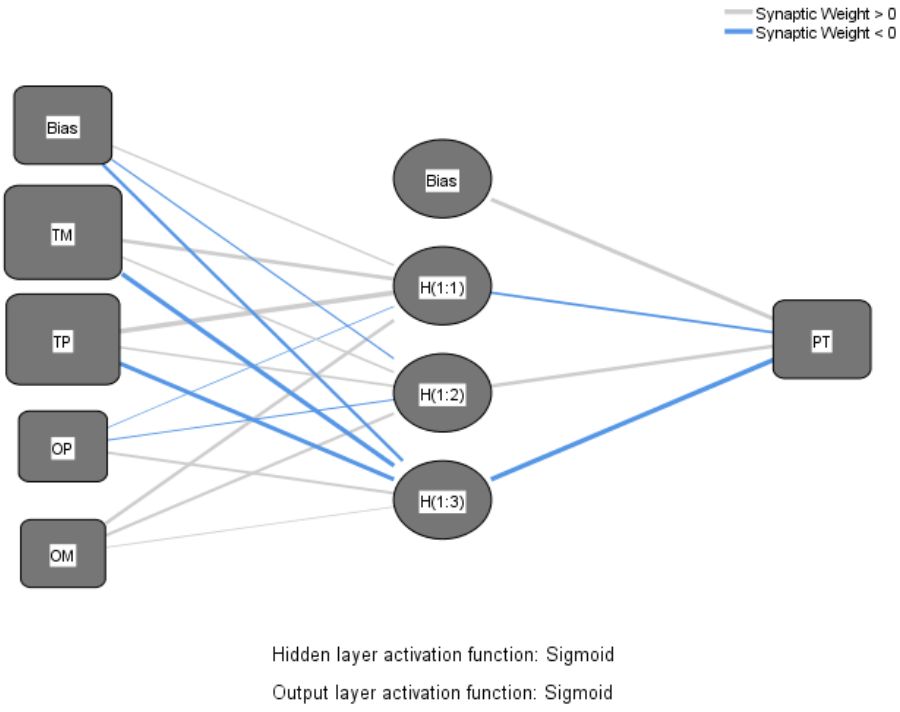

Fig 2. Neural network model

Sensitivity analysis performance was calculated using normalized importance values. The normalized importance represents the proportion of the related significance of each predictor with its maximum related significance expressed as a percentage (Ahani et al., 2017). It is worth mentioning that all variables in our model were used for sensitivity analysis therefore, m-payment provider trust was also included for this stage. The results of sensitivity analysis in the ANN model are presented in Table 8. According to the findings for normalized variable importance analysis, merchant trust is the most important factor to predict perceived trustworthiness followed by m-payment provider trust, m-payment provider opportunism, and merchant opportunism.

Table 8. The ANN-Estimated Importance of variables

	Importance	Normalized Importance	Ranking
TM	0.429	100.00%	1
TP	0.387	90.20%	2
OP	0.113	26.20%	3
OM	0.071	16.60%	4

The differences between results obtained from SEM and ANN analyses can be attributed to the non-linear and non-compensatory nature and also a higher level of accuracy in ANN models (Liébana-Cabanillas et al., 2018).

Discussion and conclusion

The present study set out to explore the dyadic role of trust and opportunism in the relationship between merchant and m-payment provider through the lenses of game theory and by employing a two-staged SEM-neural network approach. The isolated effects of merchant and m-payment provider trust and opportunism on perceived trustworthiness for the two-player model are presented in Table 9.

Table 9. Isolated effects of trust and opportunism on perceived trustworthiness

	m-payment provider	
Merchant	Trust	Opportunism
Trust	.548, .240	.548, -.179
Opportunism	.108, .240	.108, -.179

According to the results obtained from SEM analysis and factoring in the estimated importance of variables achieved through ANN, the scenario of mutual trust where both merchant and m-payment provider trust each other yields the highest significantly positive impact on the perceived trustworthiness. The next best scenario is found to be the "sucker's pay-off". In this case, the m-payment provider's trust and merchant's opportunism produced a significant positive impact on perceived trustworthiness which makes this the second-best option. The scenario of merchant trust and m-payment provider opportunism is shown to produce a negative impact on perceived trustworthiness and therefore occupies third place among all cases. And finally, the worst-case scenario is proven to be when both parties behave opportunistically. One of the interesting results as presented in Table 9 based on the SEM-ANN outputs is the significant positive sign for merchant opportunism coefficient which implies that perceived trustworthiness increases even when the merchant is behaving opportunistically. This is consistent with the results reported by Chandra et al. (2010) and Xin et al. (2015) in the context of consumer m-payment adoption. Bearing in mind that the research instrument captures the factors from the perspective of the merchants, this result can be explained by excerpts from the findings of March and Olsen (1989) who posit that the concept of inter-organizational

trust should be viewed in the context of economic exchange and also the study of Williamson (1993), who emphasizes the boundedly rational and opportunistic nature of human and thus a very calculative orientation to commercial contracting. This is in line with the findings of Moghavvemi et al. (2021) who indicate that the drivers of m-payment adoption are for the most part originating from the relative advantages linked to the benefits for the users.

This study has several key contributions to research and practice. First, as a response to Dahlberg et al.'s (2015) call for more research on merchant m-payment adoption and also the call by Liébana-Cabanillas and Lara-Rubio (2017) to focus on trust in this context, we adapted the Dahlstrom et al. (2014) model for risk of opportunism into the context of merchant and m-payment provider relationship in the Malaysian financial technology ecosystem. Given the significant role of innovative payment solutions in bringing competitive advantage, productivity, and growth to the economy (Yeboah, 2020), and considering the fact that while there is a myriad of research focusing on consumer adoption, the merchant perspective as the complementary factor to create network externalities and critical mass is under-researched; therefore exploring the adoption factors from merchants view contribute to a more nuanced understanding of merchants' mobile payment adoption, provide practical insights for stakeholders, and foster the development of effective strategies to promote adoption and maximize business outcomes. Furthermore, as the stage of market maturity can significantly impact adoption, studying the Malaysian market as a developing Asian nation can shed light on the nuances and variations in mobile payment adoption factors across different regions; understanding the specific barriers and strategies relevant to different stages of market maturity can guide authorities for policy interventions and supporting adoption efforts. Second, considering the critical role of trust in the relational exchange between consumers and service providers (Sirdeshmukh et al., 2002), the present research provided a multi-dimensional view of trust as a construct. Although our findings cohere with this notion, as highlighted in previous research (exp. Nguyen et al., 2020; Rouibah et al., 2016; Shao et al., 2019; Sharma et al., 2019; N. Singh & Sinha, 2020), we refine and extend the literature by inclusion and highlighting the significance of opportunism as an inevitable factor in relational exchange. This emphasizes the importance of contracting and the fact that the optimal contract can be achieved when both parties (in this case merchants and m-payment providers) are aware of the ingrained conditions in the economic transaction in which they are partaking and consequently, make necessary attempts to reduce their associated contractual risks. Nevertheless, given the prerequisites and associated cost in administering perfect contacts which on most occasions overweighs the benefits (Wathne & Heide, 2000), setting up a tolerance limit for opportunistic decisions by either party seems to be a more efficient approach compared to expecting complete elimination of opportunism. In this context, information will play an important role, as any party with access to more information will have the advantage and the ability to adjust the strategies accordingly which in turn signifies the role of big data analytics in the future. Third, we believe that this research is among the first attempts to explore merchant m-payment adoption through a game-theoretic framework, using a two-staged SEM-ANN approach. Given the fact that m-payment adoption literature predominantly utilizes the traditional parametric models, the application of a two-staged SEM-ANN model allowed for a more precise methodology which further improves the results. Based on the assumption that without opportunism the concept of trust yields irrelevant (Witteloostuijn, 2003), and that a game emerges as soon as parties with conflicting interests (especially in an inter-organizational context) start to interact, we employed a prisoner's dilemma model to explore the outcome of various scenarios. Our findings underscore the fact that the concept of trust and cooperation (as a non-opportunistic behavior) are closely linked. This implies that cooperation can be the observable outcome of the unobservable cognition of trust. The results show that mutual trust is still the optimum strategy for both parties, cohere with the underlying concept of prisoner's dilemma, and is consistent with previous research in a similar field (Dahlstrom et al., 2014). A game theory study in the context of mobile payment adoption can contribute to the theoretical literature by providing insights into the decision-making processes of merchants. By incorporating trust and opportunism into the game theory model, we can gain a better understanding of how they affect the decision-making process and overall adoption rates. Finally, from a practical perspective, considering the complicated and multi-faceted nature of humans, the results imply that managers should not be hampered by sticking to either relational exchange

theory or transaction cost economics theory and adopt a more tempered view while devising the exchange relationship with partners. Particularly the m-payment providers should be aware that perception of opportunism by merchants can convey a negative signal and create an atmosphere of suspicion which is detrimental to their trading partnership. One of the challenges ahead of merchants in this context is vendor selection i.e., choosing the right mobile payment solution provider and establishing partnership with relevant parties (Moghavvemi et al., 2021); however, research on decision-making process, criteria, and challenges involved in selecting mobile payment vendors and forming partnerships with financial institutions or technology companies is limited. The results of present research can provide insights into the factors that influence merchant decisions and guide them towards suitable partnerships for successful adoption.

It is worth mentioning that although the treatment of game theory in this research is fairly basic, efforts have been made to support the arguments by empirical analysis with the modest aim to signify the valuable insight that multidisciplinary research i.e., economics and game theory can bring to the context of this research. The game theory application in this research is limited to duopoly which includes two players without bargaining and explicit communication, therefore future research can focus on m-player games under bargaining situations to shed more light on the issue. Another recognized limitation of our study is the lack of account for any performance measures in our model which can be considered in future research as understanding how mobile payment adoption influences merchants' operational efficiency, customer loyalty, and financial performance over an extended period is essential for a comprehensive assessment of its benefits. Due to constraints, this research treated merchants as a homogeneous group, neglecting the heterogeneity in their characteristics and needs. Future research could investigate the differential adoption patterns and outcomes across various merchant types, such as small businesses, large retailers, service providers, and online merchants. Comparative analysis can provide insights into the unique challenges and opportunities faced by different types of merchants in adopting mobile payment technologies. Future research could also focus on identifying successful adoption strategies, examining the role of education and training programs, assessing the effectiveness of incentives, and understanding the role of payment service providers in promoting adoption.

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