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## Article

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## Examining the dynamics of mobile banking app. Adoption during the COVID-19 pandemic: A digital shift in the crisis

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### ABSTRACT

Mobile banking applications (apps) have become crucial in maintaining financial services accessibility during the COVID-19 pandemic. This study leverages the Unified Theory of Acceptance and Use of Technology (UTAUT) to examine Malaysian millennials' behavioral intentions toward mobile banking app adoption, aiming to aid banks in developing targeted strategies to expand their user base. Data collection was conducted from October 2020 to February 2021 during the peak of the COVID-19 pandemic. A survey was administered to 270 respondents using convenience and snowball sampling methods. The Sequential Least Square method was used for the analysis. Our findings reveal that performance expectancy, effort expectancy, trust, and personal innovativeness significantly influence mobile banking app adoption intentions, whereas social influence and facilitating conditions do not. Demographic factors also modulate these relationships to varying degrees. These insights contribute to theoretical discussions on technology adoption and offer practical guidance for banks looking to enhance their digital service offerings in a post-pandemic landscape. This study underscores the shifts in consumer behavior triggered by the pandemic and highlights the ongoing potential for digital banking growth in Malaysia.

### 1. Introduction

Over the past decade, technological advancements have significantly enhanced financial services, enabling consumers to perform transactions such as fund transfers, balance inquiries, bill payments, and investments through mobile banking apps, accessible anytime and anywhere (Krishanan et al., 2015). These apps, an extension of internet banking, have evolved to include cutting-edge features like artificial intelligence and biometrics, driven by the demand for a seamless user experience. The COVID-19 pandemic further accelerated the adoption of mobile banking as social distancing and remote work became the norm, facilitating timely, hassle-free financial transactions (Ragusa et al., 2021). This shift was underscored during the pandemic by a global increase in mobile banking app downloads by 20 % from Q1 to Q2 2020 (Kamath, 2020), and projections suggest that the global digital banking platform market could reach \$9 billion by 2026 (Research & Markets, 2020). The Conditional Movement Control Order significantly increased online banking activities in Malaysia, with mobile banking penetration rising

from 53.6 % to 62.8 % by January 2021 (Bank Negara Malaysia, 2021b). However, despite a mobile-cellular penetration rate of 132.8 %, mobile banking usage was reported at only 59.0 % in Q3 2020 (MCMC, 2020), indicating a substantial gap in the adoption of mobile banking services in the region. Moreover, technological advancements contribute to managing crises and enhancing a secure lifestyle. Technologies such as AI and blockchain significantly improve financial portfolios, enabling consumers to benefit from the efficiencies of mobile banking services. Integrating AI into banking technology reduces the impact of potential crises and maximizes financial opportunities. George and Sunny (2023) empirically demonstrated that mobile wallets gained popularity in India during COVID-19 due to their contactless nature, which helped avoid physical contact.

Significant growth opportunities exist in the mobile banking sector, yet it remains underutilized compared to other forms of self-service banking like ATMs or internet banking (Picoto & Pinto, 2021). Despite the widespread use of smartphones to access the Internet, a gap persists in adopting mobile banking applications. Factors such as ease of use,

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necessary skills, and security concerns hinder its broader acceptance (Raza et al., 2017). Consumers prioritize security highly in mobile banking, often hesitating to adopt the technology due to its perceived risks (Merhi et al., 2019; Phaneuf, 2021). Cultural factors and generational preferences significantly influence mobile banking usage. Millennials and Gen Z, known for their preference for convenience, increasingly dominate online and mobile banking. In the US, 97 % of millennials engage with mobile banking, surpassing % the overall consumer rate of 89 % (Brown, 2020). Similarly, in Southeast Asia, 67 % of Malaysian millennials appreciate the ease of use offered by mobile banking (Ipsos, 2017), indicating a readiness to adopt new technologies. Despite these trends, Malaysia lags behind other Asian countries in digital banking adoption, with only ten local banks offering mobile banking services as of April 2021 (Bank Negara Malaysia, 2021a).

As shown in Fig. 1, In Malaysia, the penetration rate of mobile banking subscribers has seen a dramatic increase, from 52.9 % in 2019 to 101.6 % in June 2024, reflecting a significant shift toward digital solutions over a short period of time (Bank Negara Malaysia, 2021b). However, Internet banking still predominates, with a penetration rate of 142.4 % compared to mobile banking's 101.6 % in June 2024, indicating a preference among Malaysians for traditional online platforms (Bank Negara Malaysia, 2021a).

In the Southeast Asian market, young adults aged 21 to 40, predominantly millennials known as “digital natives,” are spearheading the adoption of digital banking. These individuals, who are highly internet-savvy and more receptive to technological innovations, represent 70.2 % of the region's population using digital banking as their primary financial interface (Deloitte, 2020). This demographic trend presents Malaysia with a prime opportunity to advance its banking transformation, catering to the demand for convenience and enhanced quality of life. Historically, studies have utilized the Technology Acceptance Model (TAM) to analyze behavioral intentions toward mobile banking in Malaysia, enriching the model with constructs like perceived risk, relative advantage, and trust to bolster its predictive capacity (Daud et al., 2011; Krishnan). However, TAM has been criticized for its over-simplicity and inability to fully capture the nuances of advanced technology adoption (Salimon et al., 2017). In response, fewer researchers have adopted the Unified Theory of Acceptance and Use of Technology (UTAUT) in Malaysia, a model more comprehensive but criticized for its complexity and limited ability to predict voluntary technology use (Bagozzi, 2007; Heijden, 2004; Venkatesh et al., 2012). Addressing these gaps, this study employs an enhanced UTAUT model, integrating trust (Alalwan et al., 2017; Malaquias & Hwang, 2016; Sharma et al., 2020; Zhou, 2012a), perceived risk (Bhatt, 2016; Malaquias & Hwang, 2016; Picoto & Pinto, 2021), and personal innovativeness (Chitungo & Munongo, 2013; Malaquias et al., 2018; Zhou, 2012a) to explore how these factors influence Malaysian millennials' adoption of mobile banking applications.

Moreover, the most recent studies by Al-Qudah et al. (2024) in the UAE, Sebayang et al. (2024) in Indonesia, Ali et al. (2023) in Pakistan, Jena (2023) in India, George and Sunny (2023) in India, Tut (2023) in Kenya, Shaikh et al. (2023) and Ofosu-Ampong and Acheampong (2022) in Ghana, Alamoudi et al. (2022) in Saudi Arabia, Kapoor et al. (2022) in

India, Mu and Lee (2022) in Korea, and Al Amin et al. (2022) in Bangladesh have empirically demonstrated that mobile banking performance was exceptionally satisfactory, user-friendly, innovative, and trustworthy during the COVID-19 pandemic. Prior studies have shown that mobile banking adoption increased substantially during the pandemic. In this context, our research addresses the critical question: How do demographic variables, alongside performance expectancy, effort expectancy, social influence, facilitating conditions, trust, perceived risk, and personal innovativeness, influence Malaysian millennials' intention to adopt mobile banking applications during COVID-19? The findings of this study are anticipated to contribute to the broader understanding of mobile banking App adoption and guide effective strategy development for increasing mobile banking subscribers in Malaysia.

Following this introduction, the study proceeds with a literature review, hypothesis development, methodology, and research results and concludes with the study's implications for theory and policy.

## 2. Literature review

### 2.1. Theoretical underpinnings

Technology adoption has received much focus from researchers, as proven by many available studies and technology adoption models. The adoption of mobile banking can be studied in many ways, focusing on understanding the relationships between technology adoption and significant variables, such as using the commonly used Technology Acceptance Model framework in analyzing the intention to adopt. This model emphasized that perceived usefulness and ease of use are the underlying determinants of technology adoption and usage (Davis, 1989). George and Sunny (2023) said integrating TAM, UTAUT, and Information Systems (IS) accelerates contactless digital banking systems because of changing consumer buying behavior. However, TAM has limitations in explaining users' attitudes and behavioral intentions toward technology adoption as it does not include external variables, including economic, demographic, and trust variables. (Venkatesh & Davis, 2000). Hence, many authors expanded TAM to include additional variables, such as personal innovativeness, perceived risk, perceived cost of use, and perceived security (Chitungo & Munongo, 2013). Innovation diffusion theory (IDT), developed by (Rogers, 1995), is another technology adoption model used widely. This theory states that the adoption rate of a new technology depends on five innovation characteristics: relative advantage, compatibility, complexity, observability, and trialability. While IDT recognizes a behavioral phase showing the transition from awareness to acceptance, it does not explain how attitudes are shaped and eventually lead to acceptance or rejection, nor how innovation attributes match the process (Bhattacharjee, 2000).

### 2.2. Unified theory of acceptance and use of technology (UTAUT)

The UTAUT model was developed by Venkatesh et al. (2003) As the consolidation of the following eight theories: the theory of reasoned action (TRA), the Technology Acceptance Model (TAM), the

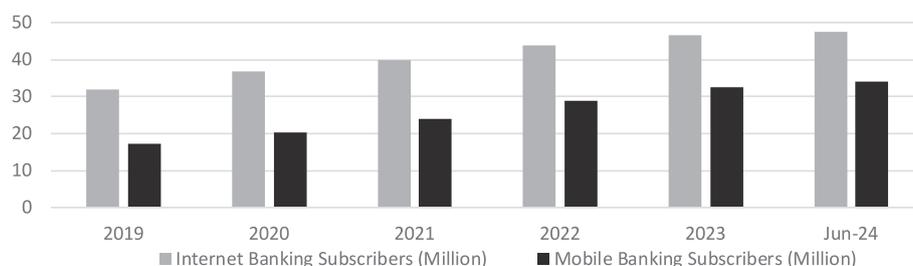


Fig. 1. Number of Internet and mobile banking subscribers in Malaysia (2019 - June 2024). Source: Bank Negara Malaysia (2021b).

motivational model, the Theory of Planned Behavior Model, the PC utilization model, IDT, social cognitive theory (SCT), and the integrated model of technology acceptance and planned behavior, this theory concentrates on the motivations for consumer behavior, such as perceived usefulness or relative advantage. Being an extension of the TAM model, it is based on four factors: performance expectancy, effort expectancy, social influence, and facilitating conditions. It was influential in concisely predicting usage and adoption intention. (Venkatesh et al., 2013). It has also been used in different countries for Internet banking, mobile payment services, and mobile banking. UTAUT was then extended into UTAUT2 by including hedonic motivation, price value, and habit variables to make the model more suitable for technology use. However, it is still subject to some limitations, such as its high complexity, which makes it difficult to assess (Bagozzi, 2007) and its limited ability to explain the voluntary use of technology (Heijden, 2004). The hedonic motivation and price value were found not supported in a mobile banking App adoption intention study carried out in a developing country (Merhi et al., 2019). As access to mobile banking applications in Malaysia is free or has a limited cost, the price value is not considered in the proposed model. According to the findings of Baptista and Oliveira (2016) Mobile banking could be seen as a functional service instead of bringing joy and pleasure; thus, this model does not consider hedonic motivation. Furthermore, the habit was not included in a mobile banking study by Alalwan et al. (2017). The respondents must be assumed to have a rich experience in using the technology to examine the role of habit, but they potentially have yet to use such technology. With the same interest, habit is not considered in this research model.

In Malaysia, most authors used modified TAM (Amin et al., 2007; Daud et al., 2011; Krishanan et al., 2015, 2016; Rehman & Shaikh, 2020; Samhale et al., 2024). In other countries, several authors used UTAUT & UTAUT2 (Alalwan et al., 2017; Boonsiritomachai & Pitchayadejanant, 2017; F. Malaquias et al., 2018; Merhi et al., 2019; Picoto & Pinto, 2021; Yu, 2012) to study the intention of mobile banking adoption. To improve the estimation of the intention to use mobile banking applications in Malaysia while retaining the constructs from UTAUT, we begin with UTAUT as the research model and expand it with additional constructs relevant to behavioral intention to use mobile banking applications. The research model is proposed based on prior research findings that extend UTAUT by adding new constructs and explaining the existing variables through hypothesis creation.

Based on the meta-analysis results on mobile banking from Shaikh and Karjaluoto (2015), three main dependent variables captured in the past literature are attitude, intention, and usage. In comparison, eight main independent variables are perceived ease of use, perceived usefulness, trust, social influence, perceived risk, perceived behavioral control (or self-efficacy), compatibility with lifestyle and device, and facilitating conditions. Sebayang et al. (2024) used a study based on the Indonesian banking sector and concluded that mobile banking technological innovation motivates people to use mobile banking services more frequently. Jena (2023) concluded that senior citizens of India are more regularly and conveniently using e-banking services. Jena (2023) and Ali et al. (2023) produced a document based on India and Pakistan that adopting mobile banking is widespread and popular with the young population and senior citizens because of its rapid performance, consistent with Tut (2023) and Shaikh et al. (2023) for Africa. The most significant influence of intention is compatibility, followed by perceived usefulness and attitude. Credibility, social impact, perceived behavioral control/self-efficacy, and perceived cost have an average low to medium effect on the intention to use mobile banking. Sharma et al. (2017) state that trust, perceived usefulness, compatibility, and social influence are significant predictors of intention to adopt mobile banking. Thus, in this study, the UTAUT model is used to study behavioral intention, with the additional construct of trust, perceived risk, and personal innovativeness consistent with Tian et al. (2022).

### 2.2.1. Performance expectancy

Performance expectancy is the degree to which a consumer believes that using a technology will benefit in performing certain activities. It has been found that it is the most vital factor in a user's behavioral intention to adopt technology (Venkatesh et al., 2012). It was shown that performance expectancy significantly positively impacts users' behavioral intention in studies of mobile internet (Chong, 2013) and mobile banking services (Sebayang et al., 2024, George & Sunny, 2023; Jena, 2023; Luo et al., 2010; Raza et al., 2017).

Mobile applications that complete transactions in a convenient and precise manner are examples of performance expectancy (Cao & Niu, 2019). Mobile banking applications are equipped with useful functions for consumers' financial transactions. Performance expectancy is used to represent the user's perceived advantages of using mobile banking, specifically making faster banking transactions such as account balance inquiry and fund transfer, representing the effect of the convenience that came with the adoption of the technology. The convenience mentioned above also includes the 24/7 availability of the services via mobile banking without location restriction (Merhi et al., 2019). Hence, the following hypothesis is developed:

**H1.** . Performance expectancy is positively related to behavioral intention (BI) toward adopting mobile banking applications.

### 2.2.2. Effort expectancy

Similar to the perceived ease of use introduced in the TAM model (Davis, 1989) and the complexity construct from DOI, effort expectancy is used in UTAUT to represent "the degree of ease associated with an individual's use of technology" (Venkatesh et al., 2012) with a positive predictive impact on intentional behavior to adopt the technology. In other words, consumers are more likely to adopt a technology that requires little effort to effectively use (Merhi et al., 2019). Mobile applications are easy to operate (Islam Dr & Mazumder, 2010), mainly due to the pervasive touchscreen devices these days (Chang et al., 2012). Consumers could feel more power over touchscreen devices due to the direct nature of touch (Brasel & Gips, 2014). According to Alalwan et al. (2017) and Raza et al. (2017), a positive relationship was shown between mobile banking's perceived usefulness and technology acceptance. Ali et al. (2023) documented that EE positively influences the mobile banking adoption of Pakistani customers. Moreover, consumers adopted mobile service systems to perform banking transactions mainly because of the service's usefulness (Luarn & Lin, 2005). Ease of use is significantly related to behavioral intention because financial transactions are generally more complex, and mobile banking has only been introduced to customers in the last decade. This is consistent with a study in Malaysia that found that effort expectancy significantly affects behavior intention to adopt mobile apps among students (Hew et al., 2015). It also influences the adoption of mobile banking (Shaikh & Karjaluoto, 2015). Therefore, the following hypothesis is developed:

**H2.** . Effort expectancy is positively related to behavioral intention (BI) toward adopting mobile banking applications.

### 2.2.3. Social influence

The term "social influence" refers to "the extent to which consumers perceive that important others believe they should use a particular technology" (Ali et al., 2023; Al-Qudah et al., 2024; Shaikh et al., 2023; Venkatesh et al., 2012). They could be family, spouse, friends, colleagues, or the social media community influencing users' perceptions and behavior. The study showed that social influence is one of the factors of behavioral intention in mobile banking adoption (Riquelme & Rios, 2010; Talukder et al., 2014; Yu, 2012). The social influence of the decision maker should be weighed when assessing the acceptance of technical advances. This is particularly true for innovations in the early stages of development or diffusion, where consumers lack detailed knowledge about the innovation (Dahlberg et al., 2008). In addition, the pressure of the social system significantly impacts innovation

acceptance in Bass's product development model 1969. According to [Fan et al. \(2005\)](#), consumers are more prone to recommend a service to others if they are satisfied with the service. Malaysia is a collective society, and social influence will significantly affect consumers' intention to use mobile banking applications, where they tend to pursue opinions from their families and friends about their past experiences. ([Wei et al., 2009](#)). This finding argued that using social influence as one of the constructs in the research model is essential. Thus, the following hypothesis is developed:

**H3.** Social influence is positively related to behavioral intention (BI) toward adopting mobile banking applications.

#### 2.2.4. Facilitating conditions

Facilitating conditions are defined as the degree to which an individual believes that an organizational and technical infrastructure exists to support the use of technology ([Venkatesh et al., 2012](#)), similar to perceived behavioral control in the Theory of Planned Behavior (TPB). This aspect can be explained by the availability of information, knowledge, time, and money to embrace mobile banking applications. When consumers have essential assistance and resources, they have the intention to use mobile applications ([Hew et al., 2015](#)). Using mobile banking apps typically requires a specific set of skills, expertise, and technological infrastructure ([Alalwan et al., 2017](#); [Zhou et al., 2010](#)). Customers could be more likely to adopt mobile banking if they get a certain level of support service and resources and see it as consistent with other technology they already use. First-time users will need to learn how to use the new mobile application, such as navigating to the required functions and completing the steps for successful transactions ([Lewis et al., 2013](#)). They argue that people usually seek assistance when they are experiencing new technology. Better facilitating conditions like online help and support, Frequently Asked Questions (FAQs), and customer service assistance led to more significant mobile banking application usage. Facilitating conditions include the costs of owning a smartphone and internet subscription fees. Given that the costs mentioned are affordable, it will positively impact the intention to adopt. Studies have shown that facilitating conditions are one of the antecedents of the adoption intention of mobile banking ([Alalwan et al., 2017](#); [Zhou et al., 2010](#)). Hence, the following hypothesis is developed:

**H4.** Facilitating conditions is positively related to behavioral intention (BI) toward adopting mobile banking applications.

#### 2.3. Trust

Trust is a subjective belief that a party will fulfill its obligations in a situation where a trustor is subject to higher uncertainty and a greater risk of loss of control ([George & Sunny, 2023](#); [Jena, 2023](#); [Tut, 2023](#); [Y. Lu et al., 2011](#)). With trust, actions occur based on consumers' optimistic assumptions ([Köksal & Penez, 2015](#)). Three values are often associated with trust: ability, honesty, and benevolence. Ability means that the service providers possess the knowledge and skills required to complete their tasks. Integrity is defined as service providers keeping their commitments and not cheating customers. Benevolence implies that service providers are concerned with the needs of their customers rather than only their own ([Zahedi et al., 2008](#)). Due to its inverse relationship with risk, trust was the main factor in technology adoption intention ([Alalwan et al., 2017](#); [R. F. Malaquias & Hwang, 2016](#); [S. K. Sharma et al., 2017](#)). Higher trust in technology means lower perceived risk and subsequently positively impacts behavioral intention.

In the mobile banking adoption context, there is institutional trust and trust in the technology or the channel ([Köksal & Penez, 2015](#)). Institutional trust refers to the confidence between consumers and financial service providers because of previous experience or a strong reputation. Hence, such expectations and emotional forces can affect users' trust in the technology. Furthermore, prior trust was found to have a substantial positive effect on mobile banking adoption ([Alalwan](#)

[et al., 2017](#); [Luo et al., 2010](#)). Concerning the mobile banking environment via smartphones, consumers are exposed to hackers, viruses, and fraud that result in long-term financial loss, increasing their concern about payment security and lowering their trust in mobile banking. This will subsequently impact their usage or intention to adopt. If customers trust the mobile banking applications, it will positively lead to adoption ([Zhou, 2012a, 2012b](#)). According to [Masrek and Razali \(2013\)](#), Malaysian consumers demand technology trust and institution-based trust in mobile banking. Thus, the following hypothesis is developed:

**H5.** Trust is positively related to behavioral intention (BI) toward adopting mobile banking applications.

#### 2.4. Perceived risk

Another important contributor to users' adoption intention is perceived risk, defined as "the users' subjective expectation of suffering a loss in pursuit of a desired outcome." ([Pavlou & Fygenon, 2006](#)). When consumers are unsure about the product quality and brand, they may doubt product delivery, incur money transactions without receiving the service, and engage in other illegal activities and fraud. It could cause a potential delay or rejection in the decision to adopt ([Amin et al. 2022](#); [Daud et al., 2011](#)). Perceived risk is a function of the amount at stake in the decision and the individual's subjective certainty that they will gain or lose all or some of the amount at stake ([Cox & Rich, 1964](#)). It reflects the concerns about using personal information without the owner's knowledge and permission. ([Akturan & Tezcan, 2012](#)); the transfer of money to third parties without the owner's knowledge and permission ([Akturan & Tezcan, 2012](#)); and the vulnerability of smartphones to hackers, viruses, and information thieves ([Zhou, 2012a](#)). People are concerned about the risk of fraud and banking services when engaged in online transactions or activities as the penetration rate of mobile phones and internet applications grows. Since the intention to use mobile banking requires some degree of ambiguity, perceived risk is considered a direct antecedent of mobile banking users' behavioral intention ([Daud et al., 2011](#)).

Ambiguity about the outcome of using the innovation or the degree of uncertainty about its security is considered PR ([Gerrard & Cunningham, 2003](#)). This factor is also related to Internet banking adoption ([Yiu et al., 2007](#)) and interest in online monetary transactions ([Liao et al., 2011](#)). However, [Daud et al. \(2011\)](#) found that perceived risk does not significantly influence the intention to adopt mobile banking in Malaysia. According to [Tan & Leby \(2016\)](#), when there was a fear of insecurity and uncertainty, people hesitated to accept mobile banking. In general, perceived risk was negatively associated with intentions toward mobile banking ([Chen, 2013](#); [Krishanan et al., 2016](#); [Rehman & Shaikh, 2020](#)). Therefore, the following hypothesis is developed:

**H6.** Perceived risk is negatively related to behavioral intention (BI) toward adopting mobile banking applications.

#### 2.5. Personal innovativeness

Personal innovativeness is associated with the relative earliness or lateness with which a person adopts an innovation to others. It is often associated with the risk-taking propensity of individuals. According to innovation diffusion studies, highly innovative individuals are active information-seekers of new ideas. They build more optimistic attitudes toward acceptance ([Rogers, 1995](#)). [Agarwal and Prasad \(1998\)](#) described it as "the willingness of a person to try out any new information technology". Users with higher personal innovativeness develop more optimistic attitudes about technology and are more likely to be early adopters ([J. Lu et al., 2005](#)). In the scope of mobile banking, the study showed that personal innovativeness significantly impacts user attitude, affecting intention toward mobile banking. ([Chitungo & Munongo, 2013](#)). Evidence from previous literature shows that personal innovativeness has a positive relationship with Internet banking

adoption (George & Sunny, 2023; Kapoor et al., 2022; Mu & Lee, 2022; Yiu et al., 2007). Personal innovativeness is related to time because some consumers (non-innovators) may take longer to implement new technologies than others (innovators). Based on this evidence, people who like to try new technologies will have more intention to adopt mobile banking. Individuals can be classified based on their innovativeness, namely innovators, early adopters, early majority, late majority, and laggards, which vary in their innovativeness and influence their likelihood of mobile banking adoption. Personal innovativeness can be assessed through attitudes to change, peer influence, communication activities, and lead characteristics. More innovative consumers are more likely to adopt mobile banking (Sulaiman et al., 2007). Hence, the following hypothesis is developed:

**H7.** Personal innovativeness is positively related to behavioral intention (BI) toward adopting mobile banking applications.

## 2.6. Demographic factors and mobile banking applications

Alalwan et al. (2015) conducted a study in Jordan and revealed the role of age, gender, education, and income on the perception of mobile banking. It was found that people between 25 and 40 years old were more willing to adopt mobile banking, possibly due to their higher capability in dealing with sophisticated technology. Besides, highly educated people were more driven to adopt mobile banking as they were more likely to have sufficient knowledge and skills than less educated people. This is consistent with another study that implies a high educational background is required to perform complex financial transactions via mobile applications (Krishanan et al., 2015). Particularly in mobile banking, Sharma et al. (2017) supplemented the TAM with demographic factors, disclosing that age was the most significant predictor after gender and education. Age was also evidenced as an essential moderator in adopting mobile banking in a study in London. (Merhi et al., 2020). Sulaiman et al. (2007) found that mobile banking is more common among younger consumers in Malaysia, consistent with Rashid et al. (2021). These findings showed that demographic (gender, age, education, income level, locality) variance affects the adoption relationships. The finding indicates that males over females, younger over senior citizens, and educated over less educated or illiterate people have the variance in the relationships.

However, a study in the Philippines showed that demographic variables had an insignificant impact on the willingness to use mobile banking, stressing the importance of segmenting customers based on their needs instead (Chiu et al., 2017). The discrepancy in findings across countries and limited similar studies in Malaysia calls for the need to study the role of demographic factors in mobile banking adoption in Malaysia as a developing country. Hence, the following hypothesis is developed:

**H8.** Demographic factors (gender, age, education level, income level) moderate the relationship between selected behavioral factors and behavioral intention toward adopting mobile banking applications, such as males having a significant effect on relationships compared to females.

## 2.7. Behavioral intention of Mobile banking application adoption

The behavioral intention has been frequently described as having a robust role in shaping the usage and adoption of new systems (George & Sunny, 2023; Kapoor et al., 2022; Mu & Lee, 2022; Venkatesh et al., 2003, 2012). Therefore, the current study assumes that the actual adoption of mobile banking could be expected mainly by the customer's willingness to adopt a technology system. Several online banking studies have also demonstrated this relationship (Alalwan et al., 2017). UTAUT, from the literature studied, has been widely applied to understanding technology adoption, including mobile banking. To improve the predictivity of the study, UTAUT is expanded with additional constructs of

trust, perceived risk, and personal innovativeness. These internal factors are backed by past research and are influential factors in the behavioral intention of mobile banking adoption. The study of consumers' intention to adopt mobile banking aligns with BNM's initiative to increase the usage of electronic financial services in Malaysia.

## 2.8. Conceptual model

Fig. 2 explains the conceptual model based on the hypothesis supported by the UTAUT model.

## 3. Methodology

### 3.1. Sample of the study

We utilized convenience and snowball sampling to recruit participants from the Klang Valley area of Malaysia, targeting individuals aged 25 to 40 who were current or prospective mobile banking users. This region was selected for its high internet penetration, which is crucial for studying digital banking trends. Data collection was conducted from October 2020 to February 2021 during the peak of the COVID-19 pandemic. A team of two researchers, led by the primary author, designed and distributed the self-administered questionnaires, ensuring efficient data collection under pandemic restrictions (Statista, 2021). To ensure that the sample data are robust for analysis, the sample size should be greater than 30 and smaller than 500 (Roscoe, 1969). The data collection was conducted via a self-administered quantitative online survey, as the results can be generalized. The online questionnaire was created in Google Forms and distributed using convenience methods to friends, family, and acquaintances through social media and messaging applications. Using the snowballing technique, a questionnaire was forwarded to their friends and family through WhatsApp or Facebook. A total of 322 questionnaire responses were collected, of which 52 responses were removed during the data-cleaning process to eliminate irrelevant data before data analysis. Finally, the research found 270 responses to further analysis.

### 3.2. Instruments used in the study

The survey consisted of close-ended questions where the respondents were given a list of choices. The measurement for each construct is adapted from research literature and measured using a seven-point Likert scale ranging from "strongly disagree" to "strongly agree." Four (4) questions combined the performance expectancy construct; the effort expectancy construct had four (4) questions; the social influence construct had four (4) questions; the facilitating conditions construct had four (4) questions; the trust construct had four (4) questions; perceived risk construct had four (4) questions; personal innovativeness construct had four (4) questions, and behavioral intention construct had four (4) questions. Among the eight (8) constructs, seven (7) are independent variables, including PE, EE, SI, FC, TR, PR, and PI. The dependent variable is the behavioral intention toward adopting mobile banking applications. The Measurement of variables and corresponding sources are presented in Appendix 2. The study followed a two-step data analysis procedure as suggested by Anderson (1988). The first step used the measurement model to check the mode's internal consistency, reliability, and validity. In the second step, a hypothesis test and path analysis were conducted in partial least square structural equation modeling (PLS-SEM). Structural Equation Modeling (SEM) has been introduced as a second-generation method for multivariate data analysis, which determines the association between independent and dependent variables; the latter specifies the relationship between each variable and its observed indicators. Raza et al. (2017) mentioned that PLS-SEM is used to form or extend existing theories. With a small sample size, a non-normal distribution of data, and a weak model, the researchers face problems in analyzing data. Moreover, in the case of

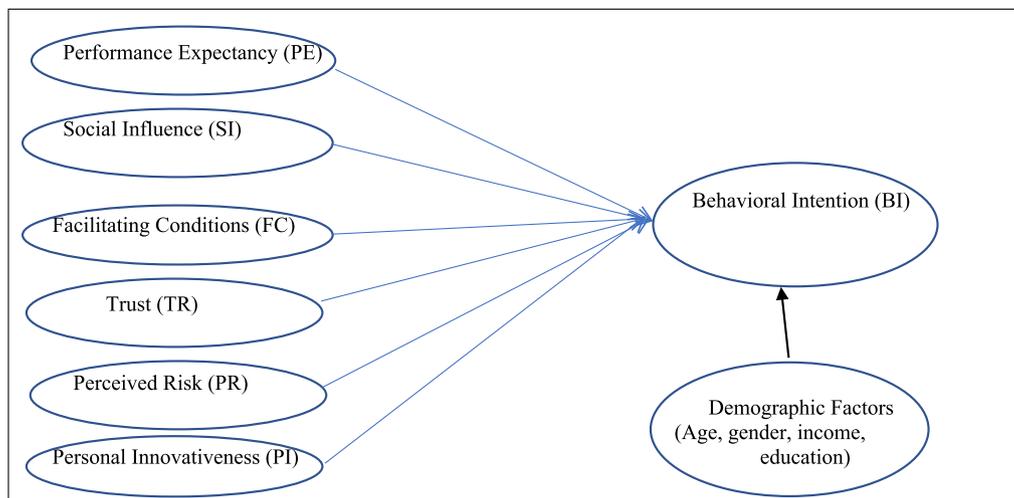


Fig. 2. Research Model

insufficient information on the relationship among variables in Hair, Ringle, & Sarstedt (2011) exploratory studies, PLS-SEM would be an effective approach for analysis compared to other methods. The application of social physiology science, the structural equation modeling (PLS-SEM) has been applied in various social science, management, and marketing research in the context of inferential analysis (Hair, Sarstedt, & Ringle, 2012). Pavlou and Fygenon (2006) argue that recently, different PLS-SEM improvements have taken place, including modeling effects’ analysis guidelines (Henseler & Fassott, 2010), use of confirmatory factor analysis for measurement model verification (Hair et al., 2011), model predictive relevance and model quality evaluation (Hair et al., 2011). Reinartz, Haenlein, & Henseler (2009) have also assured that the PLS capacity of variable analysis is important for complex models. There are two main mythological elements to consider in PLS-SEM. Hair et al. (2011) mentioned that PLS-SEM could deal with two types of indicators- formative and reflective. Another reason is that to generalize the study’s results, the result will use the SEM approach

4. Data analysis

4.1. Demographic profile

Descriptive statistics was used at the beginning of the analysis to understand the demographic profile of the respondents in terms of gender, age, race, religion, education level, income level, and occupation. Table 1 shows that the respondents comprised 44 % and 56 % of males and females, respectively. Most respondents were between 24 and 30 (46 %), while 35 % were 31 to 25. For ethnic grouping, 47 % of the respondents were Malay, 47 % were Chinese, 4 % were Indians, while others made up 2 %. Based on religion, 47 % of the respondents’ religion was Islam, followed by 38 % of Buddhists and 6 of Christians. On the other hand, most respondents were well educated; 69 % completed tertiary education, while 27 % completed a diploma/higher diploma. The primary income group of the respondents was between RM 4000 and RM 5999 (42 %), and the majority were working as company employees.

4.2. Descriptive and correlation matrix

Table 2 presents the means, standard deviation, and correlation matrix among the variables. The correlation matrix defines a strong relationship between constructs (p < 0.01). The BI positively and significantly correlates with PE, EE, SI, FC, TR, and PI. While investigating the correlation estimates among the constructs, the highest value of Pearson Correlation estimates is less than 0.617, which is below the

Table 1 Demographic profile.

Variables	Size (%)	Variables	Size (%)
<b>Gender</b>		<b>Level of Education</b>	
Male	120 (44.4)	Primary school	1 (0.4)
Female	150 (55.6)	Secondary school	10 (3.7)
<b>Age</b>		Diploma/Higher Diploma degree	74 (27.4)
24–30 years	125 (46.3)	University degree or above	185 (68.5)
31–35 years	94 (34.8)	<b>Income Level</b>	
36–40 years	51 (18.9)	< RM 2000	17 (6.3)
<b>Race</b>		RM 2000 – RM 3999	51 (18.9)
Malay	128 (47.4)	RM 4000 – RM 5999	112 (41.5)
Chinese	127 (47.0)	RM 6000 – RM 7999	36 (13.3)
Indian	10 (3.7)	RM 8000 – RM 9999	19 (7.0)
Other	5 (1.9)	RM 10,000 – RM 11,999	17 (6.3)
<b>Religion</b>		> RM 12,000	18 (6.7)
Islam	128 (47.4)	<b>Occupation</b>	
Buddha	103 (38.1)	Student	5 (1.9)
Hindu	9 (3.3)	Government Officer	33 (12.2)
Christian	17 (6.3)	Employee	181 (67.0)
Other	13 (4.8)	Entrepreneur	21 (7.8)
		Freelance	10 (3.7)
		Other	20 (7.4)

maximum level of 0.85 suggested by Kline (2005). The highest value between BI and EE didn’t exceed the critical value of 0.90, confirming no multicollinearity problem in the study (Hair, 2010; Masud, Bae, Javier, & Kim, 2019). Moreover, Table 3 demonstrates that variance inflation factors (VIFs) are less than 3.30 therefore, the study is free from multicollinearity (Ramayah et al. 2018).

4.3. Internal consistency, reliability, and validity testing

The study applied the KMO and Bartlett’s test to check the sample size. The KMO value was 0.808, above the acceptable value of 0.5, indicating that the sample was adequate. (Cerny & Kaiser, 1977). The measure of sampling adequacy was considered meritorious, suggesting it is appropriate to perform factor analysis. The Barlett’s test of Sphericity was significant as the value was 0.00 (p < 0.001). Thus, there was no significant correlation among variables.

The study used partial least square structural equation modeling (PLS-SEM) through SmartPLS software (v4.0) for the measurement model (outer model) and structural model (inner model). Construct reliability, convergent validity, and discriminant validity are assessed using the outer model assessment. As suggested by Ramayah et al. (2018), construct reliability (factor loading) and convergent validity, the assessment threshold values are indicator reliability >0.60;

**Table 2**  
Means, standard deviation and correlation.

	Mean	Std.D	PE	EE	SI	FC	TR	PR	PI	BI
PE	5.65	0.98	<b>0.698</b>							
EE	6.05	0.89	0.507**	<b>0.777</b>						
SI	5.09	1.35	0.276**	0.220**	<b>0.801</b>					
FC	5.22	0.88	0.161**	0.289**	0.375**	<b>0.753</b>				
TR	5.12	1.21	0.232**	0.337**	0.086	0.440**	<b>0.836</b>			
PR	4.29	1.29	-0.020	-0.033	0.323**	-0.094	-0.382**	<b>0.811</b>		
PI	5.01	1.06	0.114	0.288**	0.084	0.180**	0.233**	0.055	<b>0.821</b>	
BI	6.01	1.00	0.555**	0.617**	0.206**	0.300**	0.453**	-0.117	0.431**	<b>0.740</b>

\*\* . Correlation is significant at the 0.01 level (2-tailed). PE = Performance Expectancy, EE = Effort Expectancy, SI = Social Influence, FC = Facilitating Conditions, TR = Trust, PR = Perceived Risk, PI = Personal Innovativeness, BI = Behavioral Intention.

**Table 3**  
Reliability and convergent validity.

Indices	Items	Loading Factors	Cronbach' Alpha (CA)	Composite Reliability (CR)	Average Variance Extracted (AVE)	F Square	VIFs
BI	BI1	0.904	0.939	0.957	0.846		
	BI2	0.945					
	BI3	0.921					
	BI4	0.909					
EE	EE1	0.903	0.864	0.908	0.713	0.114 (S)	1.634
	EE2	0.851					
	EE3	0.741					
	EE4	0.873					
FC	FC1	0.708	0.824	0.877	0.642	0.003 (No)	1.500
	FC2	0.729					
	FC3	0.894					
	FC4	0.858					
PE	PE1	0.792	0.794	0.863	0.615	0.205 (M)	1.475
	PE2	0.793					
	PE3	0.876					
	PE4	0.660					
PI	PI1	0.874	0.873	0.912	0.724	0.166 (M)	1.139
	PI2	0.743					
	PI3	0.891					
	PI4	0.886					
PR	PR1	0.776	0.868	0.89	0.673	0.007 (No)	1.353
	PR2	0.656					
	PR3	0.962					
	PR4	0.857					
SI	SI1	0.849	0.864	0.9	0.694	0.004 (No)	1.389
	SI2	0.775					
	SI3	0.821					
	SI4	0.883					
TR	TR1	0.906	0.931	0.951	0.829	0.046 (S)	1.628
	TR2	0.934					
	TR3	0.909					
	TR4	0.893					

Cronbach's Alpha (CA) > 0.70, composite reliability (CR) > 0.70, and average variance extract (AVE) > 0.50. As shown in Table 3, the values of factor loading, CA, CR, and AVE were above the threshold values. Thus, convergent validity was obtained in the measurement model. CR and AVE were used to confirm the internal consistency of variables. The study found the above threshold value of CR and AVE; therefore, all variables were internally consistent and reliable (Masud et al., 2019).

Ramayah, Cheah, Chuah, Ting, & Memon (2018) also recommended that discriminant validity assessment be done via cross-loading (highest loading with its construct than with other constructs), the Fornell and Larcker criterion (diagonal values > than off-diagonal values), and Heterotrait-Monotrait (HTMT). According to Table 4, diagonal values were larger than respective row and column values. Table 5 shows that HTMT values are less than 0.85. Thus, it also implied that discriminant

**Table 4**  
Discriminant validity (Fornell and Larcker Criterion).

	BI	EE	FC	PE	PI	PR	SI	TR
BI	<b>0.920</b>							
EE	0.623	<b>0.844</b>						
FC	0.349	0.308	<b>0.801</b>					
PE	0.594	0.540	0.186	<b>0.784</b>				
PI	0.447	0.291	0.212	0.134	<b>0.851</b>			
PR	-0.175	-0.087	-0.081	-0.099	0.009	<b>0.821</b>		
SI	0.239	0.259	0.356	0.265	0.065	0.274	<b>0.833</b>	
TR	0.458	0.339	0.468	0.245	0.227	-0.385	0.091	<b>0.910</b>

**Table 5**  
Discriminant validity (Heterotrait-Monotrait HTMT).

	BI	EE	FC	PE	PI	PR	SI	TR
BI								
EE	0.687							
FC	0.345	0.340						
PE	0.649	0.615	0.216					
PI	0.481	0.321	0.213	0.150				
PR	0.136	0.097	0.163	0.168	0.099			
SI	0.232	0.264	0.444	0.324	0.120	0.372		
TR	0.486	0.374	0.507	0.266	0.259	0.428	0.100	

validity was achieved. Considering both convergent and discriminant validity, the measurement model (Fig. 3) was fit for path analysis (structural model) (Hair, Howard, & Nitzl, 2020).

4.4. Common method bias (CMB) analysis

In cross-section data, there is a possibility of CMB. This study was a cross-sectional survey, so the full collinearity approach to detect CMB was applied. Previously, Harman’s single-factor procedure Podsakoff, MacKenzie, Lee, & Podsakoff (2003) and correlation matrix (Pavlou et al. 2006) were popular. Guide & Ketokivi (2015) mentioned that these two approaches are no longer acceptable for detecting CMB. The full collinearity approach suggested by (Kock & Lynn, 2012) and (Kock 2015), VIF values of all constructs are checked. If these values are less than 3.30, there is no possibility of CMB (Kock & Lynn, 2012). As shown in Table 6, all VIFs were less than 3.30. Thus, no common method issue existed in this study.

4.5. Results

As stated earlier, the study was free from multicollinearity issues. Moreover, the measurement model and VIF confirmed the running of the structural model. Bootstrapping resampling procedures (no sign changes, 270, 500) were used to test the significance of the structural

**Table 6**  
Common method bias via full collinearity approach.

	BI	EE	FC	PE	PI	PR	SI	Tr
BI	–	2.277	2.382	2.117	2.191	2.348	2.349	2.261
EE	1.937	–	1.811	1.671	1.829	1.662	1.74	1.778
FC	1.534	1.484	–	1.505	1.552	1.432	1.314	1.32
PE	1.7	1.639	1.776	–	1.903	1.493	1.624	1.782
PI	1.171	1.296	1.287	1.288	–	1.222	1.317	1.272
PR	1.298	1.237	1.412	1.376	1.347	–	1.222	1.243
SI	1.37	1.292	1.301	1.346	1.389	1.175	–	1.469
Tr	1.66	1.633	1.543	1.738	1.762	1.601	1.743	–

model (Asraf et al. 2020). Fig. 4 provides the results of the PLS (Smart PLS v.4) structural model. This model explained 61 % of the variance in behavioral intention to use mobile banking applications. In addition, performance expectancy had the most potent effect on behavioral intention.

Table 7 shows hypotheses testing results, Beta, Standard Deviation, and T-statistics. Our first hypothesis, Performance Expectancy (PE), positively and significantly ( $p < 0.001$ ) influences the Behavioral Intention (BI) to adopt mobile banking apps. Hence, we accept H1. Effort Expectancy (EF) is positively and significantly ( $p < 0.001$ ) influenced Behavioral Intension (BI). Thus, we accept H2. Social Influence (SI) does not significantly impact Behavioral intention (BI). Therefore, we reject H3. In the same line, we did not find any significant relationship between Facilitating Conditions (FC) and Behavioral Intension (BI). Hence, we reject H4. We see a positive and significant ( $p < 0.001$ ) relationship between Trust (TR) and Behavioral intention (BI). Therefore, we accept H5. On the contrary, we did not see any significant relationship between Perceived Risk (PR) and Behavioral Intension (BI). Thus, we reject H6. Moreover, we find that Personal Innovativeness (PI) is positively and significantly ( $p < 0.001$ ) influenced by Behavioral Intension (BI). Thus, we accept H7. Our results are consistent with Sebayang et al., 2024, George & Sunny, 2023, Jena, 2023, Al-Qudah et al., 2024, Ali et al., 2023, Kapoor et al., 2022, Mu & Lee, 2022, Al Amin et al., 2022. Moreover, we would also like to address that our result is significant

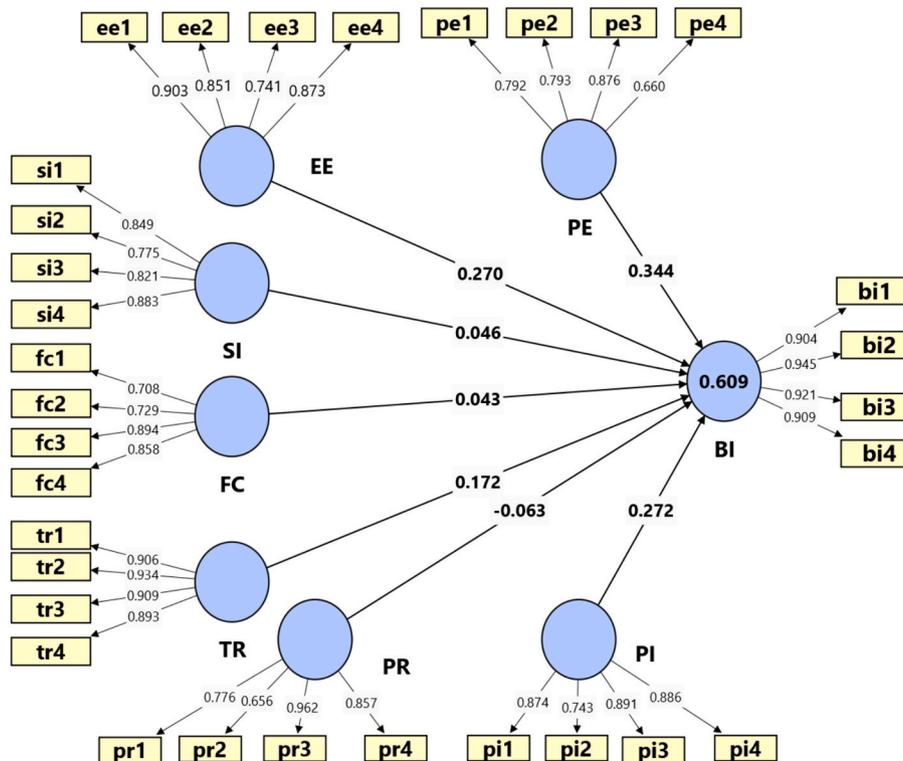


Fig. 3. Measurement model reliability and validity.

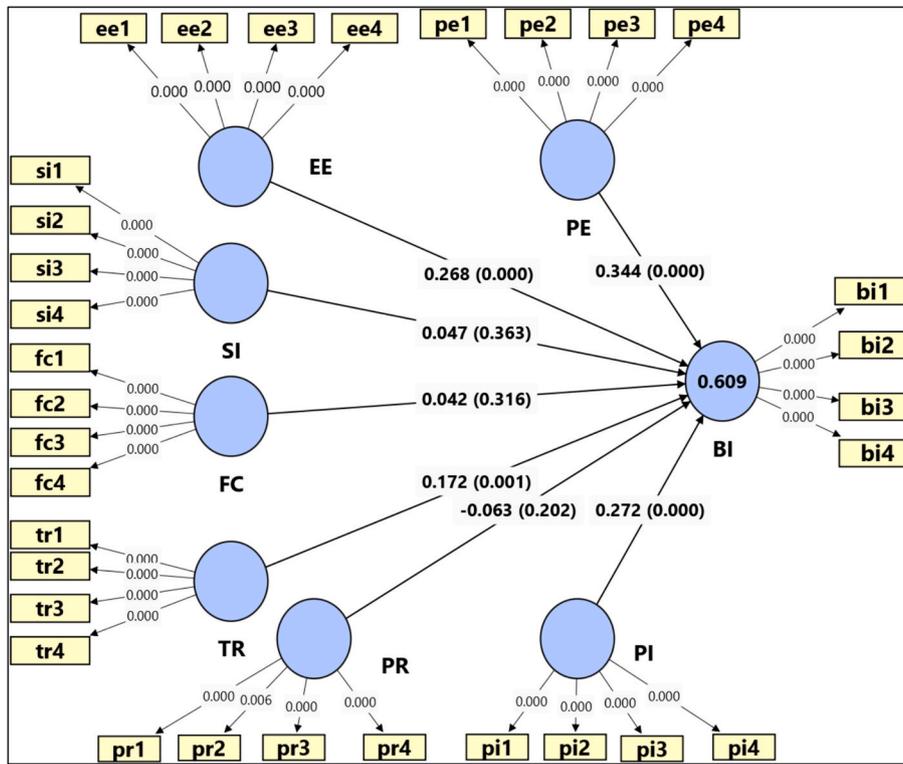


Fig. 4. Structural model and hypothesis testing.

Table 7  
Hypotheses and Path Coefficients.

Hypothesis	Paths	Beta	Std.D	T-Value	P-Values	95 % BC-CI		Decision	Q <sup>2</sup> on BI
						LL	UL		
H1	PE → BI	0.344	0.049	7.003	0.000	0.242	0.433	Accept	
H2	EE → BI	0.268	0.048	5.544	0.000	0.180	0.360	Accept	
H3	SI → BI	0.047	0.054	0.869	0.385	-0.072	0.141	Reject	
H4	FC → BI	0.042	0.041	1.037	0.300	-0.045	0.111	Reject	
H5	Tr → BI	0.172	0.05	3.473	0.001	0.073	0.261	Accept	
H6	PR → BI	-0.063	0.047	1.346	0.179	-0.132	0.092	Reject	
H7	PI → BI	0.272	0.049	5.505	0.000	0.184	0.380	Accept	0.491

from the service users' perspective. For example, financial organizations are improving financial inclusion services like E-banking, mobile banking, QR banking, Internet banking, and application-based financial services to promote and adopt technological advancement (Ali et al., 2023; Kapoor et al., 2022). Further, technological advancement and the adoption of technology-based mobile services organizations enjoy customer satisfaction and financial benefits (Al Amin et al., 2022; George & Sunny, 2023; Jena, 2023; Sebayang et al., 2024).

4.5.1. Moderating effect of demographic factors: gender, age, education, and income

This study also investigated the moderating effect of demographic factors (H8) such as gender, age, education, and income (see Table 8). Gender has a moderating effect on the relationship between social influences and behavioral intention. Respondent's age also moderates the relationships between effort expectancy and behavioral intention, perceived risk and behavioral intention, and trust and behavioral

Table 8  
Moderating effects of demographic characteristics.

Demographic	EE -> BI	PE -> BI	PI -> BI	SI -> BI	Tr -> BI
Gender				(0.098) *	
				0.155**	
Age					
	0.324**		0.242**		0.158**
	0.189**		0.288**		0.240**
	0.134*		0.243*		0.078*
Education					
	0.322**				0.217**
	0.189*				0.073*
Income					
	0.285*	0.295**	0.307**		0.086*
	0.189**	0.404**	0.246**		0.188**
	0.518**	0.164*	0.060*		0.279*
	0.020*	0.352*	0.183*		0.329*

intention. The finding of [Table 8](#) shows that hypothesis 8 was partially supported.

However, demographic factors were found to have an insignificant direct effect on Behavioral Intension (BI). Further, [Table 7](#) reveals that the Q-square value (0.491) was higher than 0, indicating this model has predictive relevance of the model. These findings suggested that mobile banking applications were significant for bank account holders regardless of demographic characteristics.

#### 4.6. Robustness test

The study used a robustness check to prove the rigor of the study. We used a linear regression model to check the result of [Table 7](#) and found the same in Appendix I. There is no difference between the Smart PLS model findings in [Table 7](#) (main result) and linear regression findings in Appendix I (robustness result). The robustness check confirms that this study is rigorous in nature.

### 5. Discussions and conclusions

This study aimed to examine the determinants that may facilitate or hinder the behavioral intention of millennials in Malaysia to adopt mobile banking applications using an extended version of the UTAUT model that includes trust, perceived risk, and personal innovativeness. The presented statistical results show that the proposed theoretical model has achieved an accepted level of predictive power with 61 % of the variance in behavioral intention explained. The  $R^2$  achieved was slightly higher than a mobile banking study using UTAUT2 that achieved 55.6 % ([Dakduk et al., 2020](#)). Additionally, all criteria related to the measurement model, including construct reliability and validity, were well accomplished. However, the results that were obtained differed from those of the UTAUT model, where a few variables needed to be supported in this study. As evidenced by the findings, the behavioral intention of Malaysian millennials to adopt mobile banking applications was influenced by performance expectancy, effort expectancy, trust, and personal innovativeness, with performance expectancy being the most significant factor, with a coefficient value of 0.317. The positive significant relationship is consistent with the results obtained by authors in mobile banking research ([Alalwan et al., 2017](#); [George & Sunny, 2023](#); [Jena, 2023](#); [Luo et al., 2010](#); [Merhi et al., 2019](#); [Sebayang et al., 2024](#); [Yu, 2012](#); [Zhang et al., 2018](#); [Zhou, 2012b](#)). Performance expectancy has also been proven to have a significant relationship with actual usage behavior ([Baabdullah et al., 2019](#)). This implies that millennials perceive mobile banking as a functional and productive utility for banking purposes.

Statistical results also confirmed the positive relationship between effort expectancy and behavioral intention, which is consistent with past studies ([Al Amin et al., 2022](#); [Alalwan et al., 2017](#); [Ali et al., 2023](#); [Al-Qudah et al., 2024](#); [Kapoor et al., 2022](#); [Merhi et al., 2019](#); [Mu & Lee, 2022](#); [Zhang et al., 2018](#)). This implies that millennials are concerned about the degree of ease or difficulty in using mobile banking applications. The situation is fuelled by the nature of mobile banking, which requires customers to perform all tasks alone in a secure environment using their knowledge and skills, without the presence of a third party or support. As a result, banks are advised to ensure user-friendly services that appeal to millennials who value aesthetics and convenience, with a simple interface that is responsive to various mobile device sizes and brands. Furthermore, trust was found to be a critical component in the adoption of mobile banking applications. The compelling effect of trust on technology adoption is supported by many past research ([George & Sunny, 2023](#); [Hanafizadeh et al., 2014](#); [Jena, 2023](#); [Luo et al., 2010](#); [Malaquias et al., 2018](#)), being a significant component of economic transactions in an online environment. This could be reasoned by the sensitive nature of computerized financial transactions that happen virtually without human interaction. As trust was found to motivate millennials toward using banking innovation, it validates the necessity

for proper security and management of consumer security concerns by banks. Appropriate security procedures, responsive customer service in handling mobile-banking-related issues, and readily available user-friendly security information fact sheets online could be accomplished to gain customer trust. Moreover, the service's security procedures and upgrade measures (such as biometric authentication) should be disclosed constantly and clearly through notifications and publications.

This study also discovered that personal innovativeness is an influencing factor that impacts millennials' behavioral intention to adopt mobile banking applications. According to [Sulaiman et al. \(2007\)](#), personality traits like personal innovativeness affect the likelihood of adopting mobile banking, stating that more innovative customers are more likely to use mobile banking. Millennials, mostly born after 1990, are more familiar with the Internet and the technology revolution that came after. Hence, they are more likely to explore and adopt mobile banking applications. The impact of personal innovativeness could also be explained by the rising mobile banking penetration rate in the last few years, with younger populations keener on using innovative banking. Banks should structure marketing strategies targeting innovators and early adopters among millennials while concurrently running always-on marketing promotions to reward customers who use new features. The results confirmed that the role of social influence contradicts this study's proposed conceptual model when evaluating the role of social influence. Social influence was found without significant variance in millennials' behavioral intention to adopt mobile banking applications. This is aligned with the study in Jordan, Lebanon, and England ([Alalwan et al., 2017](#); [George & Sunny, 2023](#); [Jena, 2023](#); [Merhi et al., 2019](#)) but differs from the observations made by [Yu \(2012\)](#) and [Zhou et al. \(2010\)](#), who confirmed the positive and significant relationship. This can be explained by the private nature of financial information to the individual, limiting the social network's influence and the conversation around it. Malaysian millennials, who are mostly middle-class and educated, are less inclined to rely on information and comments provided by others from their social network when deciding while becoming more individualistic when using highly individualistic IT services like mobile banking applications. Customers who have good experience with the technology are believed to have lesser concern about the voices in the social system ([Venkatesh et al., 2003](#)). The finding also suggests that the widespread belief regarding conservatism that affirms the traditional positive effect of social influence in the community on people's beliefs established by [Hofstede \(2001\)](#) lacks relevancy in the mobile banking field.

Contrary to our hypothesis, facilitating conditions did not significantly predict the intention to adopt mobile banking. This finding was different from the past research ([Alalwan et al., 2017](#); [Ali et al., 2023](#); [Baabdullah et al., 2019](#); [Zhou et al., 2010](#)) that stressed customers' interest in the facilities, resources, and skills needed to use mobile banking effectively; the absence of significance could be explained by the fact that millennials are technology savvy; hence, they need fewer resources and support in learning how to use a mobile application, with the aid of growing mobile phone and internet usage in Malaysia. Perceived risk was found to be insignificant toward intention to adopt mobile banking applications among millennials, similar to another study done in Malaysia ([Daud et al., 2011](#)). However, the study by [Krishanan et al. \(2016\)](#) in Malaysia, perceived risk had a substantial negative association with consumers' attitudes toward mobile banking. In Vietnam and Taiwan ([Ho et al., 2020](#)) perceived risk is also a critical factor that banks should consider when designing and promoting mobile banking applications. Additionally, our results are consistent in the context of [Al-Qudah et al. \(2024\)](#) UAE, [Sebayang et al. \(2024\)](#) Indonesia, [Ali et al. \(2023\)](#) Pakistan, [Jena \(2023\)](#), [George and Sunny \(2023\)](#), [Kapoor et al. \(2022\)](#) India, [Mu and Lee \(2022\)](#) Korea, and [Al Amin et al. \(2022\)](#) Bangladesh. Our result could be that millennials who frequently explore new technology are well aware of the risks of using mobile banking but consider that the established infrastructure is credible and reliable; hence, it does not hinder them from using the service.

Furthermore, demographic factors were found to partially moderate the relationship between selected behavioral factors and behavioral intention (BI) toward adopting mobile banking applications, consistent with Al-Qudah et al. (2024), George and Sunny (2023), and Mu and Lee (2022). Additionally, the statistical result showed that all demographic constructs displayed no significant relationship with millennials' behavioral intention to adopt mobile banking applications. This finding varies from multiple studies carried out in a broader group of populations, unlike the current study that focuses on millennials born within a specific time frame. A study done in Malaysia demonstrated that younger people are more likely to accept technologies like online banking (Sulaiman et al., 2007). In Sweden, the age and income of consumers exhibited significant effects on their attitudes toward adopting mobile payment services (Arvidsson, 2014). However, Baptista and Oliveira (2015) found that masculinity/femininity was not significant in predicting behavior intention to adopt mobile banking. The gap between this study and others could be due to the specific group of samples used in this study: millennials in Malaysia who might exhibit very similar cultural and personal traits to those of the same generation. This poses the need to compare the demographic factors across groups with a more significant difference in age (such as baby boomers versus millennials) and geographic location (such as West Malaysia versus East Malaysia). Mobile banking enhances the literature in the background of developing countries where mobile banking is growing. For scholars, this provides research opportunities to validate or extend the model developed in the study and apply it in other geographical or cultural settings related to mobile banking services. For businesses, the findings of this study improve the understanding of behavioral intention to adopt mobile banking apps, specifically among the largest consumer group, millennials. It has important implications for the Malaysian banking sector and regulators to be aware of the key components that should be considered in developing effective measures and promoting mobile banking service, also for managers to make proper decisions involving resource allocation and types of advertising campaigns to run to boost the growth of mobile banking. Aside from that, companies can use the outcome of this study to strengthen their marketing approach to winning market share by delivering more performance-driven solutions and better user journeys to customers. Banks can boost mobile banking adoption among Malaysian millennials by enhancing app performance, ensuring user-friendly design, and strengthening security measures. Clear communication of these features, targeted marketing, and responsive support will build trust and appeal to tech-savvy users. Regular updates and fintech collaborations can keep the app engaging and innovative, driving sustained usage.

This study brings attention to the need to acknowledge that technology acceptance should be considered to develop high usability services and maintain trust through safeguarding the consumers' information and data privacy. The results stress the importance of being responsive to the demands of trust from customers' point of view, making assurance of security and trust the utmost significance in upcoming strategies. Furthermore, awareness about technology is one of the keys to increasing innovativeness among consumers, which consequently leads to the adoption of mobile banking. Besides this, the study has significantly contributed to COVID-19 because mobile banking helps remote access to financial transactions without going to banks physically.

We acknowledge potential concerns regarding the applicability of our findings in the rapidly evolving context of mobile banking and post-pandemic consumer behaviors. While our study captures data from the peak of the COVID-19 pandemic, the theoretical framework based on the Unified Theory of Acceptance and Use of Technology (UTAUT) provides robust insights that transcend specific temporal contexts, offering enduring relevance. We address technological advancements and shifts in consumer expectations by integrating recent industry trends and expert forecasts into our discussion. This approach bridges the gap between our historical data and current realities and guides future banking practices and policy-making. Acknowledging the limitations of our pandemic-period data, we propose future research directions, including longitudinal studies, to continuously track and adapt to evolving consumer behaviors and technological innovations in mobile banking.

Mobile banking has transformed the banking industry despite Malaysia's discouraging acceptance rate. Being Malaysia's central bank, Bank Negara Malaysia is obliged to encourage banking industry players to improve consumer access to financial services and assist banks in developing competitive strategies that will grow the market of mobile banking users in the future. With the advancement of technology advances, competition in the banking industry has become more intense, with more innovations being fed to the market. To remain competitive, banks must develop a mobile banking system that meets customers' needs. At the same time, they benefit from cost savings with lower operating costs associated with the reduced number of traditional channels such as branches and ATMs, boosting profitability in the long run. Based on the importance and contribution, the study is not out of its limitations. The sample and responses of this study came from only millennials within Klang Valley in Malaysia; hence, it might not accurately reflect overall Malaysian millennials' attitudes and intentions toward mobile banking. It is also difficult to predict anything during the COVID-19 pandemic. Moreover, using the convenience sampling method caused the findings not to be generalized to represent the entire group. Future research can overcome this limitation by expanding the sample size and conducting future research in different cities crossing East Malaysia and Peninsula Malaysia.

#### **CRedit authorship contribution statement**

**Mahfuzur Rahman:** Writing – review & editing, Validation, Supervision, Formal analysis, Conceptualization. **Hew Pow Yee:** Writing – original draft, Data curation. **Md. Abdul Kaium Masud:** Writing – review & editing, Resources, Methodology. **Md. Uzir Hossain Uzir:** Writing – original draft, Methodology, Data curation.

#### **Declaration of competing interest**

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

#### **Data availability**

Data will be made available on request.

Appendix

**Appendix 1**  
Linear regression model for behavioral intention

Variable	Model 1	Model 2
	Coefficients (Std Error)	Coefficients (Std Error)
(Constant)	0.05 (0.393)	0.123 (0.421)
Performance Expectancy	0.323* (0.049)	0.330* (0.050)
Effort Expectancy	0.345* (0.056)	0.323* (0.057)
Social Influence	0.017 (0.036)	0.016 (0.036)
Facilitating Conditions	0.021 (0.055)	0.030 (0.056)
Trust	0.154* (0.042)	0.155* (0.043)
Perceived Risk	-0.038 (0.037)	-0.034 (0.038)
Personal Innovativeness	0.246* (0.040)	0.247* (0.041)
<i>Gender</i>		
Male		
Female		0.024 (0.083)
<i>Age</i>		
24–30 years		
31–35 years		-0.107 (0.101)
36–40 years		-0.025 (0.126)
<i>Education level</i>		
Primary school		-0.971 (0.687)
Secondary school		0.143 (0.224)
Diploma/Higher Diploma degree		-0.150 (0.105)
University degree or above		
<i>Income level</i>		
< RM 2000		0.094 (0.184)
RM 2000 – RM 3999		-0.058 (0.124)
RM 4000 – RM 5999		
RM 6000 – RM 7999		0.204 (0.133)
RM 8000 – RM 9999		0.048 (0.169)
RM 10,000 – RM 11,999		-0.164 (0.178)
> RM 12, 000		0.001 (0.177)
R <sup>2</sup>	0.578	0.599
Adjusted R <sup>2</sup>	0.567	0.569

Note: \*denotes 0.05 significance level

**Appendix 2**

Measurement of variables and corresponding sources

Items	Sources
<i>Performance Expectancy (PE)</i>	
PE1 I find mobile banking app useful in my daily life.	Venkatesh et al. (2012a),
PE2 Mobile banking app allows completing transactions faster.	Boonsiritomachai and Pitchayadejanant (2017)
PE3 Using mobile banking app increases my productivity.	
PE4 Using mobile banking app would improve my work performance.	
<i>Effort Expectancy (EE)</i>	
EE1 Learning how to use mobile banking app is easy for me.	Venkatesh et al. (2012a),
EE2 I find mobile banking app easy to use.	Boonsiritomachai and Pitchayadejanant (2017)
EE3 Friendly and clear interface makes me want to use mobile banking app.	
EE4 It is easy for me to become skilful at using mobile banking app.	
<i>Social Influence (SI)</i>	
SI1 People who influence my behavior think that I should use mobile banking app.	Venkatesh et al. (2012a),
SI2 People who are important to me think that I should use mobile banking app.	Yu (2012)
SI3 Bank officer think that I should use mobile banking app.	
SI4 Most people surrounding me use mobile banking app.	
<i>Facilitating Conditions (FC)</i>	
FC1 In my opinion, there is enough information available about mobile banking app.	Venkatesh et al. (2012a),
FC2 I feel that when needed, I will get enough guidance from the bank related to mobile banking app.	Picoto and Pinto (2021)
FC3 I think that I am aware about the benefits of mobile banking app.	
FC4 I think that I have received enough information about mobile banking app.	
<i>Trust (TR)</i>	
TR1 I believe that mobile banking app is trustworthy.	Malaquias et al. (2018),
TR2 I believe that mobile banking app seems secure.	Alalwan et al. (2017)
TR3 I believe that mobile banking app keeps its promise.	

(continued on next page)

## Appendix 2 (continued)

Items	Sources
TR4	I feel assured that legal and technological structures adequately protect me from problems on mobile banking app.
<i>Perceived Risk (PR)</i>	
PR1	I think my money could be stolen easily if I use mobile banking app. <a href="#">Malaquias and Hwang (2016)</a> ,
PR2	I worry about hacker invasion in my mobile device when I use mobile banking app. <a href="#">Picoto and Pinto (2021)</a>
PR3	I am more likely to make mistake while using mobile banking app for my banking transactions.
PR4	While using mobile banking app, it is likely that I may make mistakes in tapping out the correct pin codes.
<i>Personal Innovativeness (PI)</i>	
PI1	If I heard about a new information technology, I would look for ways to gain experience with it. <a href="#">Malaquias et al. (2018)</a> ,
PI2	Among my peers, I am usually the first to try out new information technologies. <a href="#">Sulaiman et al. (2007)</a>
PI3	I like to experiment with new information technologies.
PI4	I like to keep up with technological advances.
<i>Behavioral Intention (BI)</i>	
BI1	I intend to use mobile banking app in the future. <a href="#">Venkatesh et al. (2012a)</a>
BI2	I plan to continue to use mobile banking app frequently.
BI3	I will always try to use mobile banking app in my daily life.
BI4	I will recommend others to use mobile banking app.

## References

- Agarwal, R., & Prasad, J. (1998). A conceptual and operational definition of personal innovativeness in the domain of information technology. *Information Systems Research*, 9(2), 204–215. <https://doi.org/10.1287/isre.9.2.204>
- Akturan, U., & Tezcan, N. (2012). Mobile banking adoption of the youth market: Perceptions and intentions. *Marketing Intelligence & Planning*, 30, 444–459. <https://doi.org/10.1108/02634501211231928>
- Al Amin, M., Arefin, M. S., Alam, M. S., & Rasul, T. F. (2022). Understanding the predictors of rural customers' continuance intention toward mobile banking services applications during the COVID-19 pandemic. *Journal of Global Marketing*, 35(4), 324–347.
- Alalwan, A. A., Dwivedi, Y. K., & Rana, N. P. (2017). Factors influencing adoption of mobile banking by Jordanian bank customers: Extending UTAUT2 with trust. *International Journal of Information Management*, 37(3), 99–110. <https://doi.org/10.1016/j.ijinfomgt.2017.01.002>
- Alalwan, A. A., Rana, N. P., Dwivedi, Y. K., Lal, B., & Williams, M. D. (2015). Adoption of Mobile banking in Jordan: Exploring demographic differences on Customers' perceptions. In M. Janssen, M. Mäntymäki, J. Hidders, B. Klievink, W. Lamersdorf, B. van Loenen, & A. Zuiderwijk (Eds.), *Open and big data management and innovation* (pp. 13–23). Springer International Publishing. [https://doi.org/10.1007/978-3-319-25013-7\\_2](https://doi.org/10.1007/978-3-319-25013-7_2)
- Ali, A., Hameed, A., Moin, M. F., & Khan, N. A. (2023). Exploring factors affecting mobile-banking app adoption: A perspective from adaptive structuration theory. *Aslib Journal of Information Management*, 75(4), 773–795. <https://doi.org/10.1108/AJIM-08-2021-0216>
- Al-Qudah, A. A., Al-Okaily, M., Alqudah, G., & Ghazlat, A. (2024). Mobile payment adoption in the time of the COVID-19 pandemic. *Electronic Commerce Research*, 24(1), 427–451.
- Amin, H., Baba, R., & Muhammad, M. Z. (2007). An analysis of mobile banking acceptance by Malaysian customers. *Sunway Academic Journal*, 4, 1–12.
- Arvidsson, N. (2014). Consumer attitudes on mobile payment services: Results from a proof-of-concept test. *The International Journal of Bank Marketing: IJBM*, 32(2).
- Baabdullah, A. M., Alalwan, A. A., Rana, N. P., Kizgin, H., & Patil, P. (2019). Consumer use of mobile banking (M-banking) in Saudi Arabia: Towards an integrated model. *International Journal of Information Management*, 44, 38–52. <https://doi.org/10.1016/j.ijinfomgt.2018.09.002>
- Bagozzi, R. P. (2007). The legacy of the technology acceptance model and a proposal for a paradigm shift. *Journal of the Association for Information Systems*, 8(4), 3.
- Bank Negara Malaysia. (2021a). List of Regulatees—Bank Negara Malaysia. <https://www.bnm.gov.my/list-of-regulatees?inheritRedirect=true>
- Bank Negara Malaysia. (2021b). Payment statistics—Bank Negara Malaysia. <https://www.bnm.gov.my/payment-statistics>
- Baptista, G., & Oliveira, T. (2015). Understanding mobile banking. *Computers in Human Behavior*, 50(C), 418–430. <https://doi.org/10.1016/j.chb.2015.04.024>
- Baptista, G., & Oliveira, T. (2016). A weight and a meta-analysis on mobile banking acceptance research. *Computers in Human Behavior*, 63, 480–489. <https://doi.org/10.1016/j.chb.2016.05.074>
- Bhatt, D. (2016). Vision, applications and future challenges of internet of things: A bibliometric study of the recent literature. *Industrial Management & Data Systems*, 116, 1331–1355. <https://doi.org/10.1108/IMDS-11-2015-0478>
- Bhattacherjee, A. (2000). Acceptance of e-commerce services: The case of electronic brokerages. *IEEE Trans. Syst. Man Cybern. Part A*. <https://doi.org/10.1109/3468.852435>
- Boonsiritomachai, W., & Pitchayadejanant, K. (2017). Determinants affecting mobile banking adoption by generation Y based on the unified theory of acceptance and use of technology model modified by the technology acceptance model concept. *Kasetsart Journal of Social Sciences*, S2452315117301601. <https://doi.org/10.1016/j.kjss.2017.10.005>
- Brasel, S. A., & Gips, J. (2014). Tablets, touchscreens, and touchpads: How varying touch interfaces trigger psychological ownership and endowment. *Journal of Consumer Psychology*, 24(2), 226–233. <https://doi.org/10.1016/j.jcps.2013.10.003>
- Brown, T. (2020). *USAA offers the most sought-after mobile banking tools among the largest US financial institutions in 2020* (accessed on 11.08.2024) <https://www.emarketer.com/content/us-mobile-banking-competitive-edge-report-2020>
- Cao, Q., & Niu, X. (2019). Integrating context-awareness and UTAUT to explain Alipay user adoption. *International Journal of Industrial Ergonomics*, 69, 9–13. <https://doi.org/10.1016/j.ergon.2018.09.004>
- Cerny, B. A., & Kaiser, H. F. (1977). A study of a measure of sampling adequacy for factor-analytic correlation matrices. *Multivariate Behavioral Research*, 12(1), 43–47. [https://doi.org/10.1207/s15327906mbr1201\\_3](https://doi.org/10.1207/s15327906mbr1201_3)
- Chang, T.-Y., Tsai, C.-J., & Lin, J.-H. (2012). A graphical-based password keystroke dynamic authentication system for touch screen handheld mobile devices. *Journal of Systems and Software*, 85(5), 1157–1165. <https://doi.org/10.1016/j.jss.2011.12.044>
- Chen, C. (2013). Perceived risk, usage frequency of mobile banking services. *Managing Service Quality: An International Journal*, 23(5), 410–436. <https://doi.org/10.1108/MSQ-10-2012-0137>
- Chitungo, S. K., & Munongo, S. (2013). Extending the Technology Acceptance Model to Mobile Banking Adoption in Rural Zimbabwe. *Journal of Business Administration and Education*, 3, 51–79.
- Chiu, J. L., Bool, N. C., & Chiu, C. L. (2017). Challenges and factors influencing initial trust and behavioral intention to use mobile banking services in the Philippines. *Asia Pacific Journal of Innovation and Entrepreneurship*, 11(2), 246–278. <https://doi.org/10.1108/APJIE-08-2017-029>
- Chong, A. Y.-L. (2013). Predicting m-commerce adoption determinants: A neural network approach. *Expert Systems with Applications*, 40(2), 523–530. <https://doi.org/10.1016/j.eswa.2012.07.068>
- Cox, D. F., & Rich, S. U. (1964). Perceived risk and consumer decision-making—The case of telephone shopping. *Journal of Marketing Research*, 1(4), 32–39. <https://doi.org/10.1177/002224376400100405>
- Dahlberg, T., Mallat, N., Ondrus, J., & Bachfischer, A. (2008). Past, present and future of mobile payments research: A literature review. *Electronic Commerce Research and Applications*, 7, 165–181. <https://doi.org/10.1016/j.elerap.2007.02.001>
- Dakduk, S., Santalla-Banderali, Z., & Siqueira, J. R. (2020). Acceptance of mobile commerce in low-income consumers: Evidence from an emerging economy. *Heliyon*, 6(11), Article e05451. <https://doi.org/10.1016/j.heliyon.2020.e05451>
- Daud, N. M., Kassim, N. E. M., Seri, W., Wan, R., Said, M., Noor, M., & Ayub, A. (2011). Determining critical success factors of Mobile banking adoption in Malaysia. *Undefined Australian Journal of Basic and Applied Sciences*, 5(9), 252–265.
- Davis, F. D. (1989). Perceived usefulness, ease of use, and user acceptance of information technology. *MIS Quarterly*, 13(3), 319–340. <https://doi.org/10.2307/249008>
- Deloitte. (2020). "The Next Wave" Emerging digital life in South and Southeast Asia. <https://www2.deloitte.com/content/dam/Deloitte/cn/Documents/technology-media-telecommunications/deloitte-cn-tmt-inclusion-en-200924.pdf>
- Fan, Y., Saliba, A., Kendall, E., & Newmarch, J. (2005). *Speech Interface: An Enhancer to the Acceptance of M-Commerce Applications*. *ICMB'05*, 445–451. <https://researchout.tput.csu.edu.au/en/publications/speech-interface-an-enhancer-to-the-acceptance-of-m-commerce-appl>

- George, A., & Sunny, P. (2023). Why do people continue using mobile wallets? An empirical analysis amid COVID-19 pandemic. *Journal of Financial Services Marketing*, 28(4), 807–821.
- Gerrard, P., & Cunningham, J. (2003). The diffusion of internet banking among Singapore consumers. *International Journal of Bank Marketing*, 21, 16–28. <https://doi.org/10.1108/02652320310457776>
- Hair, J. F. (2010). *Multivariate data analysis: A global perspective*. Pearson Education.
- Hair, Howard, M. C., & Nitzl, C. (2020). Assessing measurement model quality in PLS-SEM using confirmatory composite analysis. *Journal of business research*, 109, 101–110.
- Hair, J. F., Sarstedt, M., Ringle, C. M., et al. (2012). An assessment of the use of partial least squares structural equation modeling in marketing research. *Journal of the Academy of Marketing Science*, 40, 414–433. <https://doi.org/10.1007/s11747-011-0261-6>
- Hanafizadeh, P., Behboudi, M., Koshksaray, A. A., & Tabar, M. J. (2014). Mobile-banking adoption by Iranian bank clients. *Telematics Informatics*. <https://doi.org/10.1016/j.tele.2012.11.001>
- Heijden, H. (2004). User acceptance of hedonic information systems. *MIS Quarterly*, 28(4), 695–704.
- Henseler, J., & Fassott, G. (2010). Testing Moderating Effects in PLS Path Models: An Illustration of Available Procedures. In V. Esposito Vinzi, W. Chin, J. Henseler, & H. Wang (Eds.), *Handbook of Partial Least Squares* (pp. 713–735). Berlin, Heidelberg: Springer. [https://doi.org/10.1007/978-3-540-32827-8\\_31](https://doi.org/10.1007/978-3-540-32827-8_31).
- Hew, J.-J., Lee, V.-H., Ooi, K.-B., & Wei, J. (2015). What catalyses mobile apps usage intention: An empirical analysis. *Industrial Management & Data Systems*, 115(7), 1269–1291. <https://doi.org/10.1108/IMDS-01-2015-0028>
- Ho, J. C., Wu, C.-G., Lee, C.-S., & Pham, T.-T. T. (2020). Factors affecting the behavioral intention to adopt mobile banking: An international comparison. *Technology in Society*, 63, Article 101360. <https://doi.org/10.1016/j.techsoc.2020.101360>
- Hofstede, G. (2001). Culture's consequences: Comparing values, behaviors. *Institutions and Organizations Across Nations*. In *Behaviour Research and Therapy—BEHAV RES THER*, 41. [https://doi.org/10.1016/S0005-7967\(02\)00184-5](https://doi.org/10.1016/S0005-7967(02)00184-5)
- Ipsos. (2017). The millennial influence in Asia. Ipsos <https://www.ipsos.com/en/millennial-influence-asia-2017>.
- Islam Dr, M. R., & Mazumder, T. (2010). Mobile application and its global impact. *International Journal of Engineering & Technology*, 10, 72–78.
- Jena, R. (2023). Factors impacting senior Citizens' adoption of E-banking post COVID-19 pandemic: An empirical study from India. *Journal of Risk and Financial Management*, 16(9), 380. <https://doi.org/10.3390/jrfm16090380>
- Kamath, A. (2020, August 28). Global Mobile consumer trends, 2020. MoEngage Blog <https://www.moengage.com/blog/global-mobile-consumer-trends-2020/>.
- Kapoor, A., Sindwani, R., Goel, M., & Shankar, A. (2022). Mobile wallet adoption intention amid COVID-19 pandemic outbreak: A novel conceptual framework. *Computers & Industrial Engineering*, 172, Article 108646.
- Kline, R. B. (2005). *Principles and practice of structural equation modeling* (2nd ed.). Guilford Publications.
- Kock, N., & Lynn, G. (2012). Lateral collinearity and misleading results in variance-based SEM: An illustration and recommendations. *Journal of the Association for Information Systems*, 13(7).
- Köksal, Y., & Penez, S. (2015). An investigation of the important factors influence web trust in online shopping. *Journal of Marketing and Management*, 6(1), 28.
- Krishanan, D., Khin, A., & Teng, K. (2015). Attitude towards using Mobile banking in Malaysia: A conceptual framework. *British Journal of Economics, Management & Trade*, 7(4), 306–315. <https://doi.org/10.9734/BJEMT/2015/17660>
- Krishanan, D., Khin, A. A., Teng, K. L. L., & Chinna, K. (2016). Consumers' Perceived Interactivity & Intention to use Mobile banking in structural equation modeling. *International Review of Management and Marketing*, 6(4), 883–890. <https://econjournals.com/index.php/irmm/article/view/3202>.
- Lewis, C. C., Fretwell, C. E., Ryan, J., & Parham, J. B. (2013). Faculty use of established and emerging Technologies in Higher Education: A unified theory of acceptance and use of technology perspective. *International Journal of Higher Education*, 2(2), 22. <https://doi.org/10.5430/ijhe.v2n2p22>
- Liao, C., Liu, C.-C., & Chen, K. (2011). Examining the impact of privacy, trust and risk perceptions beyond monetary transactions: An integrated model. *Electronic Commerce Research and Applications*, 10(6), 702–715. <https://doi.org/10.1016/j.elerap.2011.07.003>
- Lu, J., Yao, J., & Yu, C.-S. (2005). Personal innovativeness, social influences and adoption of wireless internet services via Mobile technology. *The Journal of Strategic Information Systems*, 14, 245–268. <https://doi.org/10.1016/j.jsis.2005.07.003>
- Lu, Y., Yang, S., Chau, P. Y. K., & Cao, Y. (2011). Dynamics between the trust transfer process and intention to use mobile payment services: A cross-environment perspective. *Information and Management*, 48(8), 393–403. <https://doi.org/10.1016/j.im.2011.09.006>
- Luarn, P., & Lin, H.-H. (2005). Toward an understanding of the behavioral intention to use mobile banking. *Computers in Human Behavior*, 21(6), 873–891. <https://doi.org/10.1016/j.chb.2004.03.003>
- Luo, X., Li, H., Zhang, J., & Shim, J. P. (2010). Examining multi-dimensional trust and multi-faceted risk in initial acceptance of emerging technologies: An empirical study of mobile banking services. *Decision Support Systems*, 49(2), 222–234.
- Malaquias, F., Malaquias, R., & Hwang, Y. (2018). Understanding the determinants of mobile banking adoption: A longitudinal study in Brazil. *Electronic Commerce Research and Applications*, 30, 1–7. <https://doi.org/10.1016/j.elerap.2018.05.002>
- Malaquias, R. F., & Hwang, Y. (2016). An empirical study on trust in mobile banking: A developing country perspective. *Computers in Human Behavior*, 54, 453–461. <https://doi.org/10.1016/j.chb.2015.08.039>
- Masrek, M. N., & Razali, M. H. (2013). Antecedents and impacts of Mobile banking transactions: A case of Malaysian consumers. *International Conference on Advanced Computer Science Applications and Technologies*, 2013, 401–405. <https://doi.org/10.1109/ACSAT.2013.85>
- Masud, M.A.K; Rashid, M; Khan, T; Bae, S.M; and Kim, J.D. (2019). Organizational strategy and corporate social responsibility: The mediating effect of triple bottom line, *International Journal of Environmental Research and Public Health*, 16(22), 4559. doi:<https://doi.org/10.3390/ijerph16224559>.
- Masud, M. A. K, Bae, S. M, Javier, M, & Kim, J. D (2019). Board Directors' Expertise and Corporate Corruption Disclosure: The Moderating Role of Political Connections. *Sustainability*, 11(16), 4491. <https://doi.org/10.3390/su11164491>
- MCMC. (2020). *Communications and multimedia: Pocket book of statistics | Malaysian communications and multimedia commission (MCMC)*. Malaysian communications and multimedia commission (MCMC) | Suruhanjaya Komunikasi Dan multimedia Malaysia (SKMM). <https://www.mcmc.gov.my/en/resources/statistics/communications-and-multimedia-pocket-book-of-stati>
- Merhi, M., Hone, K., & Tarhini, A. (2019). A cross-cultural study of the intention to use mobile banking between Lebanese and British consumers: Extending UTAUT2 with security, privacy and trust. *Technology in Society*, 59, Article 101151. <https://doi.org/10.1016/j.techsoc.2019.101151>
- Merhi, M., Hone, K., Tarhini, A., & Ameen, N. (2020). An empirical examination of the moderating role of age and gender in consumer mobile banking use: A cross-national, quantitative study. *Journal of Enterprise Information Management, ahead-of-print(ahead-of-print)*. <https://doi.org/10.1108/JEIM-03-2020-0092>
- Mu, H. L., & Lee, Y. C. (2022). Will proximity mobile payments substitute traditional payments? Examining factors influencing customers' switching intention during the COVID-19 pandemic. *International Journal of Bank Marketing*, 40(5), 1051–1070.
- Ofosu-Ampong, K., & Acheampong, B. (2022). Adoption of contactless technologies for remote work in Ghana post-Covid-19: Insights from technology-organisation-environment framework. *Digital Business*, 2(2), Article 100023.
- Pavlou, P. A., & Fyngenson, M. (2006). Understanding and predicting electronic commerce adoption: An extension of the theory of planned behavior. *MIS Quarterly*, 30(1), 115–143.
- Phaneuf, A. (2021). *State of mobile banking in 2021: Top apps, features, statistics and market trends*. *Business Insider* (accessed on 11.08.2024) <https://www.emarketer.com/insights/mobile-banking-market-trends/>.
- Picoto, W. N., & Pinto, I. (2021). Cultural impact on mobile banking use – A multi-method approach. *Journal of Business Research*, 124, 620–628. <https://doi.org/10.1016/j.jbusres.2020.10.024>
- Podsakoff, P. M., MacKenzie, S. B., Lee, J.-Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology*, 88(5), 879–903. <https://doi.org/10.1037/0021-9010.88.5.879>
- Ragusa, R., Marranzano, M., Lombardo, A., Quattrocchi, R., Bellia, M. A., & Lupo, L. (2021). Has the COVID 19 virus changed adherence to hand washing among healthcare workers? *Behavioral sciences*, 11, 53. <https://doi.org/10.3390/bs11040053>
- Ramayah, T. J. F. H., Cheah, J., Chuah, F., Ting, H., & Memon, M. A. (2018). Partial least squares structural equation modeling (PLS-SEM) using smartPLS 3.0. In *An updated guide and practical guide to statistical analysis* (pp. 967–978).
- Rashid, M. H. U., Hossain, M. A., Ahmad, A., & Ahmed, Z. (2021). Customers' intention in internet banking adoption: The moderating effect of demographic characteristics. *International Journal of Innovation and Technology Management*, 18(7).
- Raza, S., Umer, A., & Shah, N. (2017). New determinants of ease of use and perceived usefulness for mobile banking adoption. *International Journal of Electronic Customer Relationship Management*, 11, 44. <https://doi.org/10.1504/IJECRM.2017.086751>
- Rehman, Z. U., & Shaikh, F. A. (2020). Critical factors influencing the behavioral intention of consumers towards Mobile banking in Malaysia. *Engineering, Technology & Applied Science Research*, 10(1), 5265–5269. <https://doi.org/10.48084/etasr.3320>
- Reinartz, W., Haenlein, M., & Henseler, J. (2009). An empirical comparison of the efficacy of covariance-based and variance-based SEM. *International Journal of research in Marketing*, 26(4), 332–344.
- Research and Markets. (2020). Global digital banking platform market by component (solution and services), by deployment type (on-premise and cloud), by type (retail banking and corporate banking), by banking mode (online banking and Mobile banking), by region, industry analysis and forecast, 2020–2026. <https://www.researchandmarkets.com/reports/5137603/global-digital-banking-platform-market-by>.
- Riquelme, H., & Rios, R. (2010). The moderating effect of gender in the adoption of mobile banking. *The International Journal of Bank Marketing*, 28, 328–341. <https://doi.org/10.1108/02652321011064872>
- Rogers, E. M. (1995). *Diffusion of innovations*. Free Press.
- Roscoe, J. T. (1969). *Fundamental research statistics for the behavioral sciences*. Rinehart and Winston: Holt.
- Salimon, M. G., Yusoff, R. Z. B., & Mohd Mokhtar, S. S. (2017). The mediating role of hedonic motivation on the relationship between adoption of e-banking and its determinants. *International Journal of Bank Marketing*, 35(4), 558–582.
- Samhale, K., Ladwein, R., & Samhale, S. (2024). Exploring determinants of engagement in the use of IoT for healthcare during the COVID-19 pandemic: A fear-driven perspective. *Digital Business*, 4(1), Article 100072.
- Sebayang, T. E., Hakim, D. B., Bakhtiar, T., & Indrawan, D. (2024). What drives mobile banking adoption due to COVID-19 outbreaks? An empirical investigation of the younger generation in Indonesia. *Procedia Computer Science*, 1192–1203. <https://doi.org/10.1016/j.procs.2024.03.115>

- Shaikh, A. A., Glavee-Geo, R., Karjaluoto, H., & Hinson, R. E. (2023). Mobile money as a driver of digital financial inclusion. *Technological Forecasting and Social Change*, 186, 1–14.
- Shaikh, A. A., & Karjaluoto, H. (2015). Mobile banking adoption: A literature review. *Telematics and Informatics*, 32(1), 129–142. <https://doi.org/10.1016/j.tele.2014.05.003>
- Sharma, R., Singh, G., & Sharma, S. (2020). Modelling internet banking adoption in Fiji: A developing country perspective. *International Journal of Information Management*, 53, Article 102116. <https://doi.org/10.1016/j.ijinfomgt.2020.102116>
- Sharma, S. K., Govindaluri, S. M., Al-Muharrami, S., & Tarhini, A. (2017). A multi-analytical model for mobile banking adoption: A developing country perspective. *Review of International Business and Strategy*. <https://doi.org/10.1108/RIBS-11-2016-0074>
- Statista. (2021). Malaysia: Mobile broadband subscriptions by state 2020. Statista <https://www.statista.com/statistics/973262/number-of-mobile-subscriptions-in-malaysia-by-state/>.
- Sulaiman, A., Jaafar, N. I., & Mohezar, S. (2007). An overview of mobile banking adoption among the urban community. *International Journal of Mobile Communications*, 5(2), 157–168.
- Talukder, M., Quazi, A. M., & Sathye, M. (2014). *Mobile Phone Banking Usage Behaviour: An Australian Perspective*. <https://doi.org/10.14453/AABFJ.V8I4.6>
- Tian, H., Siddik, A. B., & Masukujjaman, M. (2022). Factors affecting the repurchase intention of organic tea among millennial consumers: An empirical study. *Behavioral Sciences*, 12(2), 50. <https://doi.org/10.3390/bs12020050>
- Tut, D. (2023). FinTech and the COVID-19 pandemic: Evidence from electronic payment systems. *Emerging Markets Review*, 54, 1–20.
- Venkatesh, V., Brown, S. A., & Bala, H. (2013). Bridging the qualitative-quantitative divide: Guidelines for conducting mixed methods research in information systems. *MIS Quarterly: Management Information Systems*, 37(1), 21–54. <https://doi.org/10.25300/MISQ/2013/37.1.02>
- Venkatesh, V., & Davis, F. (2000). A theoretical extension of the technology acceptance model: Four longitudinal field studies. *Management Science*, 46, 186–204. <https://doi.org/10.1287/mnsc.46.2.186.11926>
- Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly*, 27(3), 425–478. <https://doi.org/10.2307/30036540>
- Venkatesh, V., Thong, J. Y. L., & Xu, X. (2012). Consumer acceptance and use of information technology: Extending the unified theory of acceptance and use of technology. *MIS Quarterly*, 36(1), 157–178. <https://doi.org/10.2307/41410412>
- Wei, T. T., Marthandan, G., Chong, A. Y. L., Ooi, K. B., & Arumugam, S. (2009). What drives Malaysian m-commerce adoption? An empirical analysis. *Industrial Management and Data Systems*, 109(3), 370–388. <http://eprints.intimal.edu.my/213/>.
- Yiu, C., Grant, K., & Edgar, D. (2007). Factors affecting the adoption of internet banking in Hong Kong—Implications for the banking sector. *International Journal of Information Management*, 27, 336–351. <https://doi.org/10.1016/j.ijinfomgt.2007.03.002>
- Yu, C.-S. (2012). Factors affecting individuals to adopt mobile banking: Empirical evidence from the utaut model. *Journal of Electronic Commerce Research*, 13, 104–121.
- Zahedi, F., Mariam, & Song, J. (2008). Dynamics of trust revision: Using health Infomediaries. *Journal of Management Information Systems*, 24(4), 225–248. <https://doi.org/10.2753/MIS0742-1222240409>
- Zhang, Y., Weng, Q., & Zhu, N. (2018). The relationships between electronic banking adoption and its antecedents: A meta-analytic study of the role of national culture. *International Journal of Information Management*, 40, 76–87. <https://doi.org/10.1016/j.ijinfomgt.2018.01.015>
- Zhou, T. (2012a). Examining mobile banking user adoption from the perspectives of trust and flow experience. *Information Technology and Management*, 13(1), 27–37. <https://doi.org/10.1007/s10799-011-0111-8>
- Zhou, T. (2012b). Understanding users' initial trust in mobile banking: An elaboration likelihood perspective. *Computers in Human Behavior*, 28, 1518–1525. <https://doi.org/10.1016/j.chb.2012.03.021>
- Zhou, T., Lu, Y., & Wang, B. (2010). Integrating TTF and UTAUT to explain mobile banking user adoption. *Computers in Human Behavior*, 26(4), 760–767.
- Hair, J., Ringle, C., & Sarstedt, M. (2011). PLS-SEM: Indeed a Silver Bullet. *Journal of Marketing Theory and Practice*, 19, 139–151. <https://doi.org/10.2753/MTP1069-6679190202>
- Guide, V. D. R., Jr., & Ketokivi, M. (2015). Notes from the Editors: Redefining some methodological criteria for the journal\*. *Journal of operations management*, 37(1), v–viii.