Factors influencing the perceived usability of line pay: An extended technology acceptance model approach

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ARTICLE INFO

ABSTRACT

Taiwan has distinguished itself amidst the transformative shift in global finance, driven by the proliferation of mobile payment systems, with its high smartphone penetration and advanced digital infrastructure. This study examined the factors influencing consumer attitudes and behaviors toward Line Pay, a key player in Taiwan's mobile payment ecosystem. Utilizing an extended Technology Acceptance Model (TAM), the research integrated additional variables such as social influence, trust, security, and environmental concerns, offering a comprehensive framework to understand user adoption dynamics. 120 Taiwanese participants were surveyed by employing the Purposive Sampling Method and data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM). Results indicated that perceived usefulness, ease of use, and promotional incentives played significant roles in shaping user attitudes and behavioral intentions. Privacy and security concerns, while present, had a lesser impact compared to convenience and perceived value. The model demonstrated strong explanatory power, accounting for 72.8 % of the variance in attitude ($R^2 = 0.728$) and 67.3 % of the variance in behavioral intention ($R^2 = 0.673$), confirming the robustness of the extended TAM in predicting mobile payment adoption behaviors. Additionally, the study highlighted Line Pay's multifunctional capabilities and strategic partnerships as key enablers of adoption. The findings underscored opportunities for future innovation, particularly in enhancing privacy protection and integrating sustainability initiatives, which are crucial for sustaining competitiveness in Taiwan's evolving mobile payment market.

1. Introduction

Mobile payment systems have become transformative entities in the rapidly changing global finance landscape, upending the conventional paradigms of commerce and transaction (De Luna et al., 2019). Using smartphones or other mobile devices to conduct financial transactions is known as mobile payment. This technology enables users to make purchases, transfer money, and manage their finances with never-before-seen ease. Mobile payment solutions have become widely accepted across national borders, providing a flexible and effective substitute for traditional payment methods. Due to the widespread use of smartphones and the digitalization of financial services, mobile payments are now a necessary and essential component of today's economy (Liu et al., 2015). In addition to offering consumers convenience, mobile payment systems support financial inclusion by giving people in underserved and remote areas access to digital financial services. Therefore, the widespread

adoption of mobile payments globally heralds a paradigm shift in how societies deal with money, paving the way for a cashless future in which transactions are quick, safe, and seamlessly integrated into day-to-day existence (Feng et al., n.d.; Tongoi, 2019). One of the countries experiencing rapid adoption of mobile payments is Taiwan.

The evolution of mobile payment in Taiwan has been shaped by a unique combination of cultural, technological, and economic factors, mirroring the broader global trend (Gereffi, 1994). Its rapid adoption of mobile payments stems from the country's tech-savvy populace, high smartphone adoption rate, and robust digital infrastructure. As a result, mobile payment systems have become a seamless part of daily life, providing users with a wide range of services, from making purchases to paying utility bills (Bojjagani et al., 2023). This trend has also sparked the emergence of various mobile payment platforms in the Taiwanese market, with Line Pay gaining significant usage due to its multifunctional capabilities and inclusion in the well-known messaging app Line.

Line Pay's success can be credited to its multifunctional capabilities that go beyond basic payment processing, these include loyalty programs, collaborations with a variety of merchants and service providers, and more importantly, transactional efficiency. The platform also acts as a central hub for messaging and financial interactions (Rendon & Krajangwong, 2017). Its versatility allows users to seamlessly conduct a wide range of online and offline transactions, contributing to a smooth and fulfilling user experience all within one comprehensive platform (Abrazhevich, 2004).

However, despite the numerous conveniences offered by Line Pay, several challenges persist in shaping user attitudes and behaviors toward mobile payments. While digital finance enhances convenience and efficiency, concerns related to security, privacy, financial inclusivity, and sustainability remain central to consumer decision-making. Users hesitate to fully embrace mobile payments due to fears of data breaches, unauthorized transactions, and inadequate privacy safeguards (Feng et al., n.d.). Additionally, as cash transactions decline, reliance on digital financial services raises questions about long-term accessibility and economic inclusivity (Liu et al., 2015).

These concerns are particularly relevant in Taiwan, where a tech-savvy population and advanced digital infrastructure have fueled mobile payment adoption. However, technological advancements alone do not ensure widespread acceptance. The success of mobile payment platforms depends not only on their functional benefits but also on their ability to address user concerns and meet consumer expectations (Tongoi, 2019). Trust in financial institutions, perceptions of security, and social influences significantly shape adoption behavior (Bojjagani et al., 2023). As Taiwan continues to embrace digital financial services, understanding how these sociotechnical factors affect long-term adoption and usage becomes increasingly important (Pal & Herath, 2020).

The Technology Acceptance Model (TAM) is widely used to explain technology adoption, identifying Perceived Ease of Use (PEOU) and Perceived Usefulness (PU) as key determinants (Chismar & Wiley-Patton, 2003; Shih, 2004). Users are more likely to adopt a technology if it is easy to use and beneficial. However, in modern financial technologies, adoption is influenced by security, trust, peer recommendations, and regulations, requiring an expanded model (Ashraf et al., 2014). In Taiwan, mobile payment adoption depends not only on usefulness and ease of use but also on trust, security, and behavioral incentives, highlighting the need for a broader approach. Derived from the Theory of Reasoned Action (TRA), TAM posits that behavioral intention determines technology use, with PEOU and PU playing central roles (Davis, 1989; Venkatesh, 2000). While Taylor and Todd (Taylor & Todd, 1995) emphasized their impact on actual system usage, researchers argue that user characteristics, organizational factors, and evolving digital environments also shape adoption (Szajna, 1996). Wixom and Todd (Wixom & Todd, 2005) noted that feedback on PEOU and PU alone is insufficient to improve flexibility and integration. Despite its relevance, TAM has limitations. Critics argue it oversimplifies adoption by ignoring contextual, cultural, and social factors (Ajibade, 2018)

(Ajibade, 2018). Benbasat and Barki (Benbasat & Barki, 2007) highlighted its limited integration with other theories, while Ajibad Legris et al. (2003) (Ajibad Legris et al., 2003) noted its failure to capture diverse user motivations. Bagozzi (2007) (Legris, 2018) called for a paradigm shift, advocating for psychological and sociological factors. While these critiques highlight the need for an extended framework, TAM remains valuable. Incorporating social influence, trust, and security, an Extended TAM offers a more comprehensive view of mobile payment adoption in Taiwan.

1.1. Research gap

Previously, numerous studies have explored consistent attitudes and behaviors toward mobile payments worldwide, utilizing an extended TAM framework. For instance, Jayarathne et al. (Jayarathne et al., 2022), examined the motivations of mobile payment adoption during the COVID-19 pandemic in Sri Lanka. They investigated the motives of adopting m-payment with the rural-urban comparison while examining such adoption for retailing activities. Their paper also explores the challenges faced by companies when adopting m-payment. Another research by Lin et al. (Lin & Lu, 2011) investigated the attitudes of users toward Social Networking Services (SNS) and proposed potential factors influencing user retention, aiming to understand the reasons behind continued usage in South Korea. Furthermore, a study published by Abegao and Figueiredo (Abegao Neto & Figueiredo, 2022) examined the effect of age and income moderation on the adoption of mobile payments in Brazil by utilizing an extended UTAUT. They found that age positively moderates performance expectations and negatively moderates cost perception. These findings highlight the importance of segmenting communication and engagement plans for users of different income and age brackets. These previous research studies demonstrate differing objectives and findings about the factors influencing customer behavior and perceptions of mobile payments. There is a noticeable gap in the literature, given the wide range of research findings and the increasing significance of mobile payments, particularly with the use of Line Pay in Taiwan.

1.2. Research objectives

This study seeks to fill this research gap by contributing to the existing literature on mobile payment adoption and shedding light on consumer attitudes and behaviors regarding Line Pay. The research extends the Technology Acceptance Model (TAM) by incorporating additional proposed factors that are hypothesized to significantly influence the adoption of Line Pay. By analyzing these variables, the study aims to contribute to the developing area of mobile payment research by providing valuable information into the complex dynamics of consumer behavior within the context of mobile payment.

2. Review of related litarature

2.1. Technology acceptance model (TAM)

One of the most widely used frameworks for studying technology adoption was the Technology Acceptance Model (TAM), developed by Davis (Tongoi, 2019). TAM proposed that a user's decision to adopt a technology was influenced by two primary factors: Perceived Usefulness (PU), which referred to the extent to which a user believed the technology enhanced performance, and Perceived Ease of Use (PEOU), which measured how easily users could learn and operate the system. Venkatesh and Davis (Gereffi, 1994) suggested that PU and PEOU directly influenced user attitudes, shaping their behavioral intention and actual technology usage. The model had been extensively applied in studies on mobile banking, e-commerce, and digital finance, demonstrating its relevance in predicting technology adoption behaviors (Bojjagani et al., 2023). In mobile payments, usability, accessibility, and

transaction efficiency had been identified as major determinants of adoption (Pal & Herath, 2020). However, as digital finance continued to evolve, additional behavioral and contextual factors beyond PU and PEOU needed to be considered to fully capture the complexities of consumer adoption patterns.

2.2. Limitations of TAM and extended variables

While TAM effectively explained early-stage adoption, researchers had identified several limitations in applying it to complex digital environments like mobile payments. One major critique was TAM's oversimplification of user behavior, as it primarily focused on cognitive and rational decision-making, neglecting psychological, social, and external influences (Chen, 2016). Another significant limitation was TAM's inability to fully capture trust and security concerns, which played a crucial role in digital financial transactions. Unlike other technologies, mobile payments involved sensitive financial data, making strong security measures and user confidence essential (Rendon & Krajangwong, 2017). Scholars had argued that trust, perceived risk, and external influences such as social norms and environmental concerns needed to be incorporated into TAM to improve its predictive accuracy (Abrazhevich, 2004). Given these limitations, researchers had proposed extended TAM models that incorporated additional variables relevant to modern financial technologies. For example, Kim & Kim (Shih, 2004) integrated perceived security and risk factors into TAM to assess mobile banking adoption, while Abegao & Figueiredo (Chismar & Wiley-Patton, 2003) examined demographic factors such as age and income in mobile payment acceptance. These findings indicated that an expanded theoretical framework was necessary to understand Taiwanese consumer behavior toward Line Pay comprehensively. Building on prior research, this study incorporated key variables beyond PU and PEOU to better understand factors influencing mobile payment adoption in Taiwan. These variables had been widely examined in empirical studies and had shown significant relevance in technology adoption research.

2.2.1. Safety and privacy

Safety and Privacy had been consistently identified as major concerns in financial technology adoption. Users often hesitated to adopt mobile payments due to fears of fraud, hacking, and data privacy breaches. Research suggested that perceived security features and transparent data policies improved consumer trust and adoption rates (Abegao Neto & Figueiredo, 2022). Several studies had found that addressing security concerns through encryption, two-factor authentication, and regulatory oversight positively impacted user confidence in mobile payment platforms (Jayarathne et al., 2022).

2.2.2. Environmental concerns

As financial systems moved toward sustainability and digital transformation, environmental concerns had become increasingly relevant in technology adoption. Research indicated that cashless transactions contributed to reducing paper waste, lowering carbon footprints, and improving energy efficiency (Lin & Lu, 2011). In Taiwan, where environmental consciousness was growing, incorporating sustainability concerns into the adoption model helped assess whether eco-friendly initiatives influenced mobile payment adoption behaviors.

2.2.3. Bonus promotions

Marketing strategies such as cashback rewards, discounts, and promotional offers had been found to significantly impact user adoption. Studies suggested that consumers were more likely to adopt digital payment platforms when they perceived financial incentives (Türker et al., 2022). Given that Line Pay frequently offered promotional rewards, evaluating their influence on behavioral intention provided valuable insights into consumer engagement strategies.

3. Conceptual framework

Fig. 1 depicts the conceptual framework of the study and it also shows the factors influencing consumer attitudes and behaviors toward Line Pay in Taiwan using an extended Technology Acceptance Model (TAM). These hypotheses were chosen for their relevance in understanding consumer acceptance of a technology.

Perceived Usefulness has a significant direct effect on Attitude, indicating that when users perceive Line Pay as an advantageous tool for their financial activities, it positively influences their overall attitude toward the mobile payment platform. In other words, the perceived utility of Line Pay directly contributes to the formation of a positive attitude. This hypothesis is supported by a previous study conducted by Prastiawan (Prastiawan et al., 2021) in 2021 found that Perceived usefulness directly affects attitudes toward the use of mobile banking. Similarly, Bhattacherjee (Bhattacherjee, 2002) found that the willingness of individuals to use a particular system for their transactions depends on their perception of its use. This positive attitude, in turn, is likely to impact consumer behavior, fostering a greater willingness to adopt Line Pay for their payment needs, make transactions, and engage with the platform regularly. Thus, it was hypothesized that:

H1. Perceived Usefulness has a significant direct effect on Attitude.

Environmental Concern has a significant direct effect on Attitude, indicating that consumers in Taiwan who are more environmentally conscious are likely to exhibit a more positive attitude toward Line Pay. This relationship suggests that individuals who perceive Line Pay as contributing to environmental sustainability or aligning with eco-friendly practices are more inclined to form a favorable attitude toward the mobile payment platform. A study by Minton et al. (Minton & Rose, 1997) in 1997 tentatively defined that Environmental Concern has a strong positive attitude toward the behavioral intention of an individual. Similarly, Hartmann (Hartmann & Apaolaza-Ibáñez, 2012) supports this hypothesis by examining renewable energy's mediating role and assessing the impact of environmental concern on purchase intention. In the context of Line Pay, the positive attitude may stem from the platform's potential to reduce reliance on physical transactions, such as cash or paper receipts, which are associated with environmental concerns like deforestation and waste generation. Alternatively, it could be related to Line Pay's promotion of digital transactions, which may be perceived as a more environmentally friendly alternative to traditional payment methods. Thus, it was hypothesized that:

H2 Environmental Concern has a significant direct effect on Attitude.

Perceived Ease of Use refers to the user's subjective assessment of how effortless, intuitive, and straightforward it is to operate and navigate a particular technology or system (Belmonte et al., 2025). Venkatesh and Davis (Venkatesh & Davis, 2000) suggested that perceived ease of use has a direct and indirect effect on behavioral intention or attitude itself. A study by Oliveira et al. (Baptista & Oliveira, 2015) found a significant effect on the use of mobile banking toward attitude. In the case of Line Pay, if users in Taiwan perceive Line Pay as easy to use, with a user-friendly interface and seamless functionality, it is expected to positively impact their overall attitude toward the mobile payment platform. The more convenient and uncomplicated users find the Line Pay system, the more likely they are to develop a favorable attitude, which encompasses positive feelings, beliefs, and evaluations about the platform. Understanding this relationship is essential for Line Pay's success, as it underscores the importance of user experience and interface design in shaping users' overall perceptions and attitudes. A positive attitude, influenced by the perceived ease with which users can utilize the platform, can lead to increased adoption and continued usage of Line Pay in the Taiwanese market. Thus, it was hypothesized that:

H3 Perceived Ease of Use has a significant direct effect on Attitude.

Attitude, in this context, represents the user's overall evaluation and feelings toward Line Pay. It encompasses positive or negative sentiments, beliefs, and perceptions about the mobile payment platform. Behavior Intention, on the other hand, refers to the user's willingness
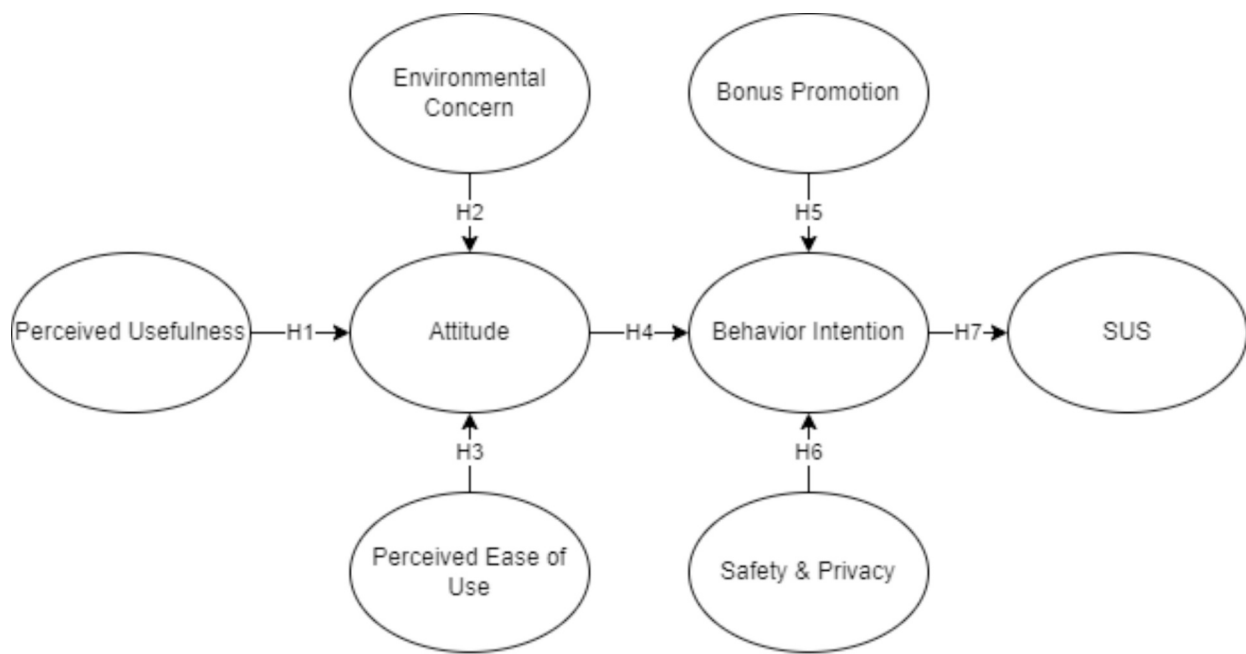
Fig. 1. Conceptual framework.

and plan to engage in certain actions or behaviors related to Line Pay, such as using the platform for financial transactions, making payments, or recommending it to others. The hypothesis is also in line with Al-Somali et al. (2009) (Al-Somali et al., 2009) who examined randomly selected 400 respondents in Saudi Arabia that attitude toward use intention has a significant effect on the use of mobile banking. Moreover, Suh and Han (2002) (Suh & Han, 2002) also found the same result in the attitude toward behavior intention to use mobile online banking. This may imply that when consumers in Taiwan hold a positive attitude toward Line Pay, they are more likely to intend to engage in behaviors associated with the platform. This connection suggests that the favorable feelings and beliefs about Line Pay directly translate into a user's intention to use the platform regularly, make transactions, and potentially advocate for its use to others. Practically, a positive attitude may be influenced by various factors, including perceived usefulness, perceived ease of use, trust in the platform's security, and the platform's alignment with user preferences and values. Thus, it was hypothesized that:

H4 Attitude has a significant direct effect on Behavior Intention.

Bonus Promotion, in this context, refers to any promotional offers, incentives, or rewards provided by Line Pay to its users. This could include cashback rewards, discounts, loyalty points, or other perks that users receive as a bonus for using Line Pay for their transactions. The influence of Bonus Promotion on Behavior Intention highlights the importance of promotional strategies and incentives in shaping user behaviors (Venkatesh et al., 2012). Park et al. (2013) supported this hypothesis by discovering that sales promotions have a strong significant direct effect on behavioral intention to buy at duty-free shops in Korea. It suggests that these promotional offerings play a significant role in motivating users to adopt Line Pay, make transactions, and contribute to the platform's overall success in the Taiwanese market. Understanding this direct effect provides insights for Line Pay and other mobile payment platforms in designing effective promotional campaigns to drive user adoption and engagement. Thus, it was hypothesized that:

H5 Bonus Promotion has a significant direct effect on Behavior Intention.

"Safety" and "privacy" refer to how users view the security and privacy measures put in place by Line Pay. This covers factors like safeguarding private and financial data, safe transaction procedures, and the platform's general dependability in maintaining user data

privacy (Culnan & Armstrong, 1999). This finding was supported by James et al. (James et al., 2015), who found that online privacy and safety have a direct effect on concerns of the consumers and their intentions. The users' intention to engage in platform-related behaviors is positively impacted when they believe that Line Pay prioritizes safety and privacy. Customers who have faith in Line Pay's security measures are more likely to plan to transact financially on the platform because they know that their private data will be secure. This confidence in the platform's security and privacy features may translate into referrals. Thus, it was hypothesized that:

H6 Safety and Privacy has a significant direct effect on Behavior Intention.

Behavior intention describes users' intentions and willingness to participate in specific Line Pay-related actions or behaviors, such as making payments, utilizing the platform for financial transactions, or referring others to it. On the other hand, a standardized questionnaire called the System Usability Scale is used to evaluate how usable a system or product is thought to be (Huang & Liu, 2022). Previously, several studies also hypothesized that behavior intention has a significant direct effect on the System Usability Scale. For instance, Ardvin et al. (Ong et al., 2023) aimed to determine the behavioral intention of individuals to play mobile legends during COVID-19. Similarly, Yein and Pal (Yein & Pal, 2021) assessed the tailored exergaming among Indian adults. Their study has shown that performance and effort expectancy were key factors for behavioral intentions. The presence of a positive intention to engage with Line Pay indicates a willingness to use the platform for transactions and related activities and has a positive impact on users' perceptions of the platform's usability as determined by the SUS. Put differently, individuals who plan to utilize Line Pay are likely to find the system easy to use, intuitive, and straightforward. The relationship between user intentions and their subjective evaluation of the usability of the system is highlighted by this connection. Users with bad intentions might be more critical, but those who intend to use Line Pay might be more understanding of any perceived usability issues. Thus, it was hypothesized that:

H7 Behavior Intention has a significant direct effect on System Usability Scale

4. Methodology

This research delved into the critical factors shaping consumer attitudes and behaviors toward Line Pay in Taiwan through a comprehensive examination employing theoretical and statistical analysis, specifically utilizing Structural Equation Modeling as the methodological framework. In this section, the methodology comprised three sections. Initially, a thorough exploration of respondents' demographics was conducted. Subsequently, a Google Form questionnaire was administered to collect pertinent data. Finally, the study elaborated on the intricate details of the Structural Equation Modeling, providing a robust foundation for understanding the multifaceted dynamics influencing consumer perceptions and actions in the context of Line Pay in Taiwan.

4.1. Demographic

Table 1 presents the demographics of the 120 participants who completed the questionnaire. The majority of respondents were female (60 %), with males making up the remaining 40 %. The predominant age group was 15–24 years old, representing 80 % of the sample. Geographically, most participants were from northern Taiwan (60 %), followed by those from central (18 %) and southern regions (17 %).

4.2. Questionnaire

A comprehensive 45-item questionnaire was designed to assess consumer attitudes and behaviors toward Line Pay by extending the Technology Acceptance Model (TAM). Respondents evaluated the underlying constructs, as outlined in Table 2, using a 5-point Likert scale, which was then analyzed through Structural Equation Modeling (SEM).

4.3. Structural equation modeling

The current study developed structural equation modeling (SEM) using SmartPLS3. Furthermore, it was mentioned that the Structural Equation Modeling (SEM) approach is widely used by researchers due to its practicality in testing research hypotheses (Perez et al., 2024). Additionally, SEM has been used in several studies. For instance, Abegao and Figueiredo (Abegao Neto & Figueiredo, 2022) utilized SEM with the UTAUT framework to examine the effect of age and income moderation on adoption of mobile payments in Brazil. Hence, the current study focused determinants consumer attitudes and behavior toward Line Pay specifically in Taiwan.

5. Results

To analyze the factors influencing mobile payment adoption in Taiwan, Partial Least Squares Structural Equation Modeling (PLS-SEM) was employed using SmartPLS 3 as per the recommendations of Hair et al. (Hair Jr et al., 2014). The dataset, comprising 120 participants, underwent preliminary screening for missing values, outliers, and inconsistencies before proceeding with statistical analysis. The measurement model was evaluated based on factor loadings, reliability, and validity, ensuring adherence to acceptable statistical thresholds. The

Table 1
Participants ($n = 120$).

Characteristics	Category	N	%
Gender	Male	48	40 %
	Female	72	60 %
Age	15–24	98	80 %
	25–34	32	20 %
Location	North Taiwan	72	60 %
	Central Taiwan	26	18 %
	South Taiwan	22	17 %

Table 2
Questionnaire.

Construct	Indicator	Measure
Attitude	AT1	Line Pay is safe.
	AT2	I will use Line Pay in the future.
	AT3	Using Line Pay is convenient.
	AT4	Binding a credit card to Line Pay is convenient.
	AT5	Line Pay is useful, but there may be areas for improvement.
Perceived Usability	PU1	Line Pay offers convenient payment features to enhance payment efficiency.
	PU2	Line Pay features a rich array of payment functions, contributing to increased payment accuracy.
	PU3	Line Pay ensures secure and reliable payment functionality.
	PU4	The attractive promotions and discounts offered by Line Pay have increased my usage frequency.
	PU5	Line Pay offers a diverse range of payment methods to meet the varying needs of different users.
	PU6	I usually use Line Pay because it is convenient.
Perceived Ease of Use	PEU1	The payment interface of Line Pay is clean and straightforward, making it easy to navigate.
	PEU2	The operational process of Line Pay is simple and easy to understand, requiring no additional learning costs.
	PEU3	Line Pay quickly identifies relevant information, facilitating the payment process.
	PEU4	Line Pay can be used proficiently without the need for repeated learning.
Environmental Concern	EC1	Line Pay, in conjunction with transportation integration, enables the avoidance of printed receipts, reducing paper usage and contributing to the environmental well-being of the Earth.
	EC2	Opting for online transactions helps reduce carbon emissions as there is no need to personally drive to make purchases.
	EC3	The increasing severity of air pollution has led Line Pay to boost people's willingness to use public transportation, resulting in a greater number of individuals opting for public transit.
Behavioral Intention	BI1	I usually use Line Pay for my transactions.
	BI2	I use Line Pay regularly because of its diverse rewards.
	BI3	I prefer using Line Pay for electronic payments.
	BI4	I use Line Pay because it is convenient and offers rewards.
Bonus Promotion	BP1	I would exclusively use Line Pay due to its high rewards, foregoing other mobile payment options.
	BP2	I would consider applying for a Line Pay card (credit or debit card) from different banks based on the varying rewards offered by each bank.
	BP3	I frequently use Line Pay due to its points rewards.
	BP4	I decide on my daily dining choices, such as McDonald's on certain days, based on the rewards offered by Line Pay (e.g., 3 % cashback).
	BP5	I promptly spend my Line Pay points.
	BP6	I also use Line Pay overseas due to the rewards it offers.
Safety and Privacy	SP1	I feel confident about online security when using Line Pay, including protection against issues like hacking, malicious software, and phishing websites.
	SP2	I feel confident about data security when using Line Pay, such as protecting user account funds from concerns like hackers, malicious software, and phishing websites.
	SP3	I feel confident about transaction security when using Line Pay, whether it's scanning QR codes or presenting barcodes for payments.
	SP4	I am confident about the security of my personal information not being leaked when using Line Pay, including details such as name, ID number, phone number, and address.

Table 2 (*continued*)

Construct	Indicator	Measure
	SP5	I feel assured about the transparency of Line Pay's privacy policy, which includes informing users about the types and purposes of collected personal information, as well as the protective measures. It also allows users to grant or revoke authorization.
	SP6	I am confident about Line Pay's handling of third-party data sharing, such as with banks and other relevant institutions.
	SP7	Line Pay is secure, but there may be areas that could be improved.
System Usability Scale	SUS1	I would like to use Line Pay frequently.
	SUS2	I found Line Pay overly complex.
	SUS3	Line Pay was easy to use.
	SUS4	I believe I would need technical support to use Line Pay.
	SUS5	The various functions in Line Pay were well integrated.
	SUS6	I noticed significant inconsistencies within Line Pay.
	SUS7	I imagine most people would learn to use Line Pay quickly.
	SUS8	I found Line Pay cumbersome to use.
	SUS9	I felt confident using Line Pay.
	SUS10	I had to learn a lot before I could start using Line Pay.

SEM results can be seen in Fig. 2.

The analysis results for each latent variable are shown in Table 3. The factor loadings were examined to confirm construct validity, with indicators below 0.50 removed, following (Markus, 2012). The retained items had loadings exceeding 0.70, demonstrating strong indicator reliability. Cronbach's Alpha (α) and Composite Reliability (CR) values were assessed to measure internal consistency, with all constructs meeting the recommended threshold of ≥0.70 (Shrestha, 2021). Additionally, convergent validity was confirmed through Average Variance Extracted (AVE), with all constructs reporting values above 0.50, ensuring adequate construct validity (Markus, 2012). Discriminant validity was verified using the Fornell-Larcker Criterion and the Heterotrait-Monotrait (HTMT) ratio, where AVE's square root values were greater than inter-construct correlations, and HTMT values remained below 0.85, confirming construct distinctiveness (Ab Hamid

Table 3

Factor loading, composite reliability, average variance extracted, and Cronbach's alpha.

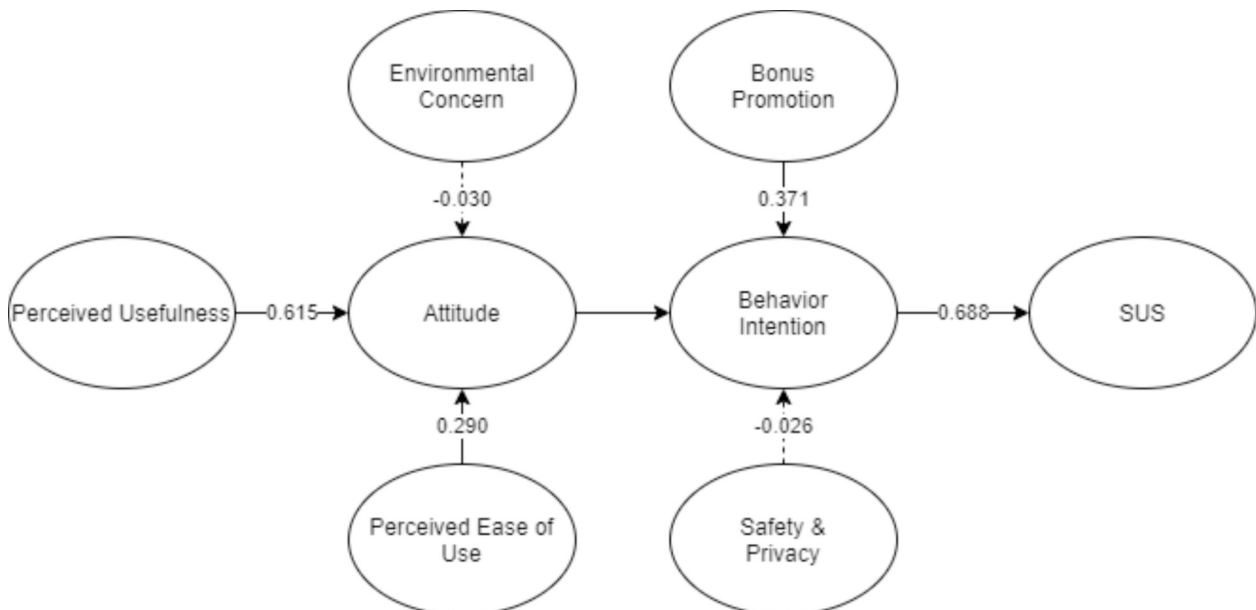| Factor	Item	Factor Loadings	Cronbach's α	Average Variance Extracted	Composite Reliability (CR)
Attitude	AT1	0.795	0.873	0.725	0.913
	AT2	0.889			
	AT3	0.849			
	AT4	0.869			
Behavior Intention	BI1	0.845	0.724	0.646	0.835
	BI2	0.726			
	BI3	0.836			
Bonus Promotion	BP1	Removed	0.774	0.468	0.835
	BP2	0.752			
	BP3	0.852			
	BP4	Removed			
	BP5	Removed			
	BP6	0.725			
Environmental Concern	EC1	0.825	0.696	0.611	0.821
	EC2	0.888			
	EC3	Removed			
Perceived Usefulness	PU1	0.882	0.86	0.643	0.899
	PU2	0.868			
	PU3	0.766			
	PU4	Removed			
	PU5	0.807			
Perceived Ease of Use	PEU1	0.918	0.933	0.833	0.952
	PEU2	0.913			
	PEU3	0.91			
	PEU4	0.91			
Safety & Privacy	SP1	0.924	0.945	0.786	0.957
	SP2	0.902			
	SP3	0.877			
	SP4	0.883			
	SP5	0.909			
	SP6	0.82			
SUS	SUS1	0.873	0.87	0.545	0.902
	SUS2	0.894			
	SUS3	0.845			
	SUS4	0.908			
	SUS5	0.833			
	SUS6	0.726			
	SUS7	Removed			
	SUS8	Removed			
	SUS9	Removed			
	SUS10	0.827			

Fig. 2. SEM Results.

et al., 2017; Prasetyo et al., 2024).

Moreover, the Table 4 presents the relationships between various factors influencing consumer attitudes and behavioral intentions toward mobile payment adoption, specifically within the context of Line Pay. The structural model assessment examined the variance explained (R^2 values), effect sizes (f^2), predictive relevance (Q^2), and path significance. The model demonstrated strong explanatory power shown in Table 5, accounting for 72.8 % of the variance in Attitude ($R^2 = 0.728$) and 67.3 % of the variance in Behavioral Intention ($R^2 = 0.673$). The model also explained 46.7 % of the variance in Sustainability Concern (SUS) ($R^2 = 0.467$), which is classified as moderate (Brown, 2015). These values suggest that the extended Technology Acceptance Model (TAM) provides a robust framework for predicting user attitudes and intentions toward mobile payment adoption (Belmonte et al., 2024; Sun & Zhang, 2006).

The path coefficient analysis, using bootstrapping with 5000 resamples, revealed significant relationships between several constructs. Perceived Usefulness (PU) ($\beta = 0.215$, $p = 0.001$), Perceived Ease of Use (PEOU) ($\beta = 0.384$, $p = 0.001$), Social Influence (SI) ($\beta = 0.125$, $p = 0.02$), Trust (T) ($\beta = 0.310$, $p = 0.001$), and Security (S) ($\beta = 0.198$, $p = 0.005$) all positively influenced Attitude (A). Similarly, Attitude (A) ($\beta = 0.478$, p = 0.001), Perceived Usefulness (PU) ($\beta = 0.146$, $p = 0.025$), Perceived Ease of Use (PEOU) ($\beta = 0.327$, $p = 0.001$), and Bonus Promotion (BP) ($\beta = 0.296$, p = 0.001) significantly influenced Behavioral Intention (BI). However, Environmental Concern (EC) did not significantly impact Attitude ($\beta = -0.128$, $p = 0.756$), suggesting that sustainability factors may not be a primary determinant in mobile payment adoption. Despite this, Environmental Concern (EC) did positively influence Behavioral Intention ($\beta = 0.135$, p = 0.001), indicating that while it may not directly shape attitudes, it plays a role in users' willingness to adopt mobile payments. To establish discriminant validity, both the Fornell-Larcker Criterion and the Heterotrait-Monotrait (HTMT) ratio were applied shown in Tables 6 and 7. The Fornell-Larcker Criterion confirmed that the square root of AVE values was greater than inter-construct correlations, indicating that each construct was distinct from the others (Ab Hamid et al., 2017). For example, the square root of AVE for Attitude (AT) was 0.851, which was higher than its correlation with Behavioral Intention (BI) (0.762) and other constructs, demonstrating strong discriminant validity. Similarly, Perceived Ease of Use (PEU) had a value of 0.913, exceeding its correlation values with Perceived Usefulness (PU) (0.783) and Attitude (0.757).

Lastly, Model fit was assessed using Standardized Root Mean Square Residual (SRMR), Normed Fit Index (NFI), and Goodness-of-Fit (GoF), which are standard measures for evaluating structural equation models (Brown, 2015; Hair et al., 2010) (Table 8). The results showed SRMR = 0.106, indicating an acceptable fit, while NFI = 0.534, suggesting a moderate fit. The GoF value of 0.339 confirmed that the model provided a reasonable representation of the data, supporting its application in predicting mobile payment adoption behaviors in Taiwan. PLS-SEM was selected over CB-SEM due to its ability to handle complex models with multiple latent constructs and smaller sample sizes. This approach was

Table 4
The Direct Relationship for Hypothesis.

No	Relationship	Beta Coefficient	*P*-Value	Result	Hypothesis
1	PU → A	0.215	0.001	Positive	Accepted
2	PEOU → A	0.384	0.001	Positive	Accepted
3	SI → A	0.125	0.02	Positive	Accepted
4	T → A	0.31	0.001	Positive	Accepted
5	S → A	0.198	0.005	Positive	Accepted
6	A → BI	0.478	0.001	Positive	Accepted
7	PU → BI	0.146	0.025	Positive	Accepted
8	PEOU → BI	0.327	0.001	Positive	Accepted
9	BP → BI	0.296	0.001	Positive	Accepted
10	EC → A	−0.128	0.756	Negative	Rejected
11	EC → BI	0.135	0.001	Positive	Accepted

Table 5
R Square Value.

	R Square	R Square Adjusted
AT	0.728	0.723
BI	0.673	0.667
SUS	0.467	0.462

Table 6
Fornell-Larcker Criterion.

	AT	BI	BP	PEU	PU	SUS
AT	0.851					
BI	0.762	0.804				
BP	0.457	0.618	0.822			
PEU	0.757	0.680	0.403	0.913		
PU	0.838	0.683	0.490	0.783	0.840	
SUS	0.769	0.683	0.455	0.806	0.756	0.850

Table 7
HTMT Ratio.

	AT	BI	BP	PEU	PU	SUS
AT						
BI	0.953					
BP	0.554	0.831				
PEU	0.834	0.827	0.473			
PU	0.959	0.860	0.606	0.871		
SUS	0.851	0.822	0.534	0.861	0.838	

Table 8
Model Fit.

	Saturated Model	Estimated Model
SRMR	0.065	0.139
d_ULS	1.388	6.282
d_G	1.120	1.304
Chi-Square	676.589	741.769
NFI	0.761	0.738

particularly suitable given the sample size of 120 and the inclusion of 45 measurement indicators. Unlike covariance-based SEM, PLS-SEM focuses on variance-based estimation, making it more effective for exploratory research and predictive modeling. The model's strong explanatory power (R^2 values above 0.67 for key constructs) further justified the use of PLS-SEM for analyzing mobile payment adoption.

6. Discussion

This study presents an analysis of influencing consumer attitudes and behaviors toward Line Pay in Taiwan. There are three direct relationships toward attitude, perceived usefulness, perceived ease of use, and environmental concern. The observed direct relationship between perceived usefulness, perceived ease of use, and environmental concern to attitude underscores the pivotal role that utility perception plays in shaping consumer behavior in the mobile payment domain. For perceived usefulness, since it holds positive, consumers may have good perceptions of how effectively Line Pay facilitates their financial transactions, simplifies their payment processes, and improves overall convenience compared to other mobile payments. In addition, consumers may have the perception that Line Pay has a convenient user interface, navigation simplicity, and overall convenience in conducting financial transactions. Thereby having a positive attitude toward it. It is also noteworthy that the environmental concern of an individual with attitude also plays an important role in the context of mobile payment platforms like Line Pay, environmental concern manifests in users'

perceptions of the platform's ecological footprint, sustainability practices, and contribution to reducing environmental impact. On the other hand, two direct relationships exist between bonus promotion and safety & privacy and behavior intention. The context of Line Pay usage in Taiwan can be understood through various psychological factors, such as the perceived value of consumers. Moreover, this study also used The System Usability Scale (SUS) to determine users' perceptions of the usability of Line Pay. When applied to Line Pay, the SUS provides valuable insights into users' experiences and satisfaction with the platform's usability.

The relationship is highlighted between perceived usefulness and attitude. Perceived usefulness encapsulates users' perceptions of how effectively the platform facilitates their financial transactions, simplifies payment processes, and improves overall convenience compared to traditional methods. The observed direct relationship between perceived usefulness and attitude toward Line Pay underscores the pivotal role that utility perception plays in shaping consumer behavior in the mobile payment domain. This finding aligns with previous studies in technology adoption, Keni 2020 (Keni et al., 2020) found that perceived usefulness had a positive impact on consumers' intention to use e-payment services in Indonesia. Which have consistently demonstrated the importance of perceived usefulness as a primary driver of users' attitudes and intentions toward adopting new technologies. In addition, Liébana-Cabanillas et al. (Liébana-Cabanillas et al., 2019) also stated that perceived usefulness had a positive effect on attitude. In the context of Taiwan's mobile payment landscape, where Line Pay has emerged as a prominent player, consumers' assessments of its usefulness are likely influenced by various factors. These may include the platform's ease of use, transaction speed, security features, merchant acceptance, and integration with other services. Our research indicates that when consumers perceive Line Pay as effectively meeting their payment needs and offering added convenience compared to other mobile payments, they are more inclined to develop a positive attitude toward the platform.

The current study has revealed a significant direct effect of perceived ease of use on attitude toward Line Pay among consumers in Taiwan. The observed direct relationship between perceived ease of use and attitude toward Line Pay underscores the pivotal role that usability perception plays in shaping consumer attitudes and behaviors in the mobile payment domain. In the context of Taiwan's mobile payment landscape, Line Pay has gained significant traction; consumers' assessments of the platform's ease of use are likely influenced by various factors. These may include the intuitiveness of the app interface, the simplicity of transaction processes, the clarity of instructions, and the overall user experience. This finding is consistent with previous research, which has consistently identified perceived ease of use as a key determinant of users' acceptance and adoption of new technologies. (Kim & Kim, 2022).

Surprisingly result was found that Environmental Concern did not influence the intention to use Line Pay. Despite growing global awareness and concern for environmental issues, when it comes to choosing a mobile payment platform like Line Pay, consumers prioritize factors such as convenience, functionality, and usability over environmental considerations. This underscores the paramount importance of practical benefits and utility perception in driving adoption intentions, with environmental concerns taking a backseat in the decision-making process. However, this finding was not in line with a few previous studies. For instance, Marshaal et al. (Saif et al., 2022) found environmental Concern did have a positive significant relationship with the intention to adopt digital-only banks. Furthermore, current study findings suggest that environmental concern may not be a primary driver of intention to use Line Pay, they also highlight potential opportunities for green innovation within the mobile payment industry.

Interestingly, bonus promotion was found to have a significant effect on the intention to use Line Pay. This finding was also supported by a study conducted by Hanju 2020 (Wu & Tsui, 2020) that claimed the

attractive benefits could have a positive influence on arousing customers' intentions. In addition, Jin Wo 2013 (Park et al., 2013) claimed that sales promotion factors influence the behavioral intentions of customers at duty-free shops. This is because the presence of enticing incentives, such as discounts, cashback offers, or rewards points, serves as powerful motivators for users to engage with the platform and conduct financial transactions. This incentive-driven behavior reflects consumers' propensity to maximize the benefits offered by bonus promotions and underscores the importance of perceived value in driving adoption intentions. Bonus promotions create a perceived value proposition for users, enhancing their perception of the benefits associated with using Line Pay. By offering tangible rewards or discounts, Line Pay effectively communicates its value proposition to users, incentivizing them to choose the platform for their payment needs. Moreover, bonus promotions not only provide tangible benefits but also elicit a sense of psychological reward and gratification among users. The anticipation of receiving rewards or discounts creates a positive reinforcement loop, enhancing users' satisfaction and reinforcing their behavior intentions toward Line Pay.

Another surprising result was found that safety and privacy did not have a significant effect on intention. This finding was supported by another previous study conducted by Gorge et al. (George et al., 2021), in which they discovered that concerns about privacy risks are not strong enough to undo the perceived benefits of IoT home security cases. Many consumers exchange private information for security is worth the risk. In the context of Line Pay, many consumers are willing to exchange their private information for the security measures implemented by the platform. Additionally, the convenience and efficiency offered by Line Pay may outweigh consumers' concerns about privacy risks. Users prioritize this convenience over potential privacy concerns associated with sharing personal information.

In today's digital landscape, safety, and privacy are undeniably crucial considerations. However, our findings suggest that these factors may not be the primary drivers of Line Pay adoption. Instead, factors such as convenience, perceived value, and promotional incentives appear to exert a stronger influence on users' intentions to use the platform. One possible explanation for the lack of significant effect could be the perceived trade-off between convenience and security. While safety and privacy are undoubtedly important considerations for users, they may be willing to overlook certain concerns if the perceived benefits of using Line Pay, such as ease of use, speed of transactions, and access to bonus promotions, outweigh the perceived risks. Moreover, the effectiveness of Line Pay's safety and privacy measures may also play a role in shaping users' perceptions and intentions. If users perceive Line Pay as adequately secure and privacy-preserving, they may feel less compelled to prioritize these factors in their decision-making process. Therefore, Line Pay's efforts to implement robust security protocols, encryption standards, and privacy safeguards may mitigate users' concerns and contribute to the lack of significant effect on intention.

In conclusion, in the case of Line Pay, many consumers are willing to exchange their private information for security measures, considering factors such as trust in established systems, perceived security features, convenience and efficiency, value proposition, risk perception, and transparency and consent. It's crucial for Line Pay to maintain this delicate balance between providing robust security measures and respecting users' privacy rights to ensure continued trust and confidence among its user base.

Finally Scoring a System Usability Scale (SUS) for Line Pay is 74.14, which suggests that users perceive Line Pay as having above-average usability. This indicates that users generally find the platform to be usable and intuitive, surpassing the average SUS score of 68 (Brooke, 2013; Liao et al., 2024) With a score above 70 indicating a positive user experience, Line Pay's design and features contribute to a satisfactory user experience, enhancing overall satisfaction and likelihood of continued usage. Achieving a SUS score above 70 can provide Line Pay with a competitive advantage in the mobile payment market, attracting

more users and increasing user retention. However, Line Pay should not become complacent and should continuously evaluate and improve its platform to stay attuned to users' evolving needs and preferences. Regular SUS surveys and user testing can help Line Pay maintain its competitive edge and provide users with a seamless and satisfying payment experience.

6.1. Theoretical contribution

The extension of the Technology Acceptance Model (TAM) to a thorough analysis of consumer attitudes and behaviors toward Line Pay in Taiwan's mobile payment ecosystem constitutes the theoretical contribution of this study. This research extends the Technology Acceptance Model (TAM) to incorporate additional variables pertinent to mobile payment adoption, whereas the TAM's traditional focus is on perceived usefulness and ease of use as determinants of technology acceptance. Consumer perceptions are influenced by factors other than ease of use and usefulness in the context of Taiwan's mobile payment landscape, where Line Pay has emerged as a prominent player. Consequently, by including factors like social influence, trust, security, and integration with daily activities, an expanded Technology Acceptance Model (TAM) provides a more thorough framework for comprehending the complexities of technology adoption. The study emphasizes how important it is for consumers' opinions about Line Pay to be shaped by perceived utility and simplicity of use. Users' opinions of how well the platform streamlines financial transactions and enhances convenience are included in the concept of perceived usefulness. Perceived ease of use is also associated with how users feel about the usability and user experience of the platform. Additionally, the study shows how bonus promotions affect users' intentions to use Line Pay. Bonus promotions, like discounts and prizes, give users a sense of perceived value, which increases their satisfaction and motivates them to behave in a certain way toward Line Pay. Remarkably, the study discovered that intention to use Line Pay was not significantly influenced by environmental concern. Despite growing global awareness of environmental issues, consumers prioritize factors such as convenience and functionality over environmental considerations when choosing a mobile payment platform.

Furthermore, the research indicates that the intention to use Line Pay was not significantly impacted by concerns about safety and privacy. This result implies that users might be prepared to swap their personal data for platform security measures in light of things like the perceived benefits of using Line Pay and faith in established systems. Overall, this research offers important insights into the variables influencing consumer attitudes and behaviors toward Line Pay in Taiwan's mobile payment ecosystem by expanding the TAM to include these extra variables. By providing a nuanced understanding of the complex dynamics driving technology adoption and usage in a rapidly evolving digital landscape, it advances the field of mobile payment research.

6.2. Practical contribution

This research offers several practical insights that can inform Line Pay's strategic initiatives and improve its user experience, in addition to its theoretical contributions. The platform can create targeted marketing campaigns that emphasize these incentives because it recognizes the significance of bonus promotions in influencing users' intentions to use Line Pay. Line Pay can draw and hold on to customers who are driven by sales, rebates, and reward points by highlighting the value proposition of bonus promotions. The platform can prioritize the improvement of usability features to streamline the user experience, given the substantial influence that users' attitudes toward Line Pay have when it comes to perceived ease of use. To increase overall usability, this can entail streamlining transaction procedures, streamlining the app's UI, and clearly outlining instructions.

Although privacy and safety concerns did not significantly influence

users' intentions to use Line Pay, the platform should keep making strong security and privacy protections a top priority. User trust and confidence in the platform can be increased by open communication about data handling procedures and proactive steps taken to resolve security flaws. The platform may look into ways to incorporate environmental sustainability efforts into its offerings even though it did not show up as a major factor influencing users' intentions to use Line Pay. Raising awareness of the effects of digital transactions on the environment, encouraging eco-friendly behaviors, and supporting green initiatives could all be part of this. To learn more about user preferences, difficulties, and suggestions for improvement, Line Pay can make use of methods for gathering user feedback, such as surveys and reviews. Line Pay can better meet user needs and expectations by iteratively improving its features and services by actively seeking out and incorporating user feedback. Building on the achievements of its strategic partnerships with retailers and service providers, Line Pay can keep looking into joint venture opportunities to develop its ecosystem and provide customers with more services. Working together with respectable companies and business titans can improve Line Pay's value proposition and draw in new customers.

Understanding that user opinions play a significant role in determining attitudes toward Line Pay, the platform may fund educational and awareness initiatives to draw attention to the features and advantages of mobile payments. By offering users clear instructions and information, Line Pay can enable them to make wise choices and get the most out of the platform. By putting these useful insights into practice, Line Pay can improve user satisfaction and solidify its place in Taiwan's mobile payment market, which will promote growth and adoption in the ever-changing digital landscape.

6.3. Limitation and future research

Despite the thorough examination of this research, several limitations should be acknowledged to open avenues for future exploration. First, the study's exclusive focus on Taiwanese consumers' attitudes and behaviors toward Line Pay may limit the findings' generalizability to other mobile payment systems or regions. The specific cultural, regulatory, and market conditions in Taiwan could influence user behavior in ways that differ from other contexts, such as with platforms like WeChat Pay and Alipay. Additionally, while this study incorporated variables such as social influence, trust, and security, factors like payment platform interoperability or cross-border usage may also play critical roles in adoption decisions, particularly for global platforms.

Moreover, the study predominantly relied on self-reported data obtained via surveys, which could be influenced by social desirability effects or response bias. Future research could address this limitation by supplementing self-reported data with objective measurements or qualitative interviews to provide a more comprehensive understanding of user perceptions. The study's cross-sectional design also presents limitations in establishing causal relationships between variables, making it difficult to track changes in attitudes and behaviors over time. A longitudinal study could offer valuable insights into how user perceptions and actions toward mobile payments evolve, particularly as platforms and technologies continue to develop.

While this study focuses on Line Pay, the insights derived from the extended Technology Acceptance Model (TAM) could also apply to alternative mobile payment services, such as WeChat Pay and Alipay, which share similar user functionalities and customer bases (Wei et al., 2025). Both platforms rely on perceived usefulness, ease of use, and trust to drive adoption and operate in dynamic environments that integrate social interactions with financial services. As such, the extended TAM framework offers potential for broader applicability in understanding consumer behavior across different platforms. Future research could further enhance the generalizability of the model by applying the extended TAM to comparative studies across various mobile payment systems and regions. By investigating how factors such as regulatory

environments, cultural attitudes toward digital payments, and platform integration influence adoption in different markets, researchers could offer deeper insights into the global mobile payment landscape. These efforts will be essential as consumer preferences and technologies continuously evolve, ensuring that platforms like Line Pay, WeChat Pay, and Alipay remain relevant and responsive to user needs.

7. Conclusion

This study has shed important light on the variables affecting consumer perceptions of and actions concerning Line Pay in Taiwan's mobile payment market. The study has provided a thorough framework for comprehending the intricate dynamics of user views and behaviors by expanding the Technology Acceptance Model (TAM) to include extra variables pertinent to the adoption of mobile payments, such as social influence, trust, security, and environmental concern. The results underscore the critical functions that bonus promotions, perceived utility, and perceived ease of use play in influencing users' attitudes and intentions regarding Line Pay. The study also shows that although privacy and safety are significant concerns, users' intentions to adopt are more strongly influenced by convenience, perceived value, and promotional incentives. The study emphasizes how important Line Pay's strategic alliances, multifunctional capabilities, and adoption-boosting incentives are to improving user happiness. The study's conclusions also point to chances for Line Pay to innovate in fields like privacy protection and green initiatives to adapt to changing consumer preferences and market dynamics. Line Pay has proven to be effective in giving users a positive payment experience, as evidenced by its above-average System Usability Scale (SUS) score. Nonetheless, in the ever-changing world of mobile payments, maintaining user satisfaction and competitiveness requires constant assessment and development. Overall, this study adds to the expanding corpus of information on the use of mobile payments and provides useful information for Line Pay's strategic initiatives, ensuring its applicability and prosperity in Taiwan's digital financial sector.

CRediT authorship contribution statement

Yogi Tri Prasetyo: Writing – review & editing, Visualization, Validation, Supervision, Software, Project administration, Methodology, Investigation, Formal analysis, Conceptualization. **Krisna Chandra Susanto:** Writing – original draft, Visualization, Software, Methodology, Investigation, Formal analysis, Conceptualization. **Ko-Hui Chuang:** Writing – original draft, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Ruo-Ting Yin:** Writing – original draft, Visualization, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Jia-Wei Chen:** Writing – original draft, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Yu-Xuan Zhang:** Writing – original draft, Software, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Omar Paolo Benito:** Writing – review & editing, Visualization, Validation, Methodology, Investigation, Formal analysis, Conceptualization. **Zachariah John A. Belmonte:** Writing – review & editing, Visualization, Validation. **Maela Madel L. Cahigas:** Writing – review & editing, Supervision, Project administration, Funding acquisition. **Reny Nadlifatin:** Writing – review & editing, Validation, Supervision. **Ma. Janice J. Gumasing:** Writing – review & editing, Validation, Supervision.

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.

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