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Technological Attributes, Perceived Value, and Digital Literacy in Mobile Banking Adoption: An Informatics Service System Perspective from Vietnam

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Abstract. This study investigates the moderating role of digital literacy in the relationships between technological characteristics, perceived value, and the intention to use mobile banking services within the Vietnamese emerging market. The research extends Innovation Diffusion Theory by integrating it with the Value-based Adoption Model, positioning digital literacy as a critical capability-based moderator. A quantitative research design was utilized, analyzing survey data from 240 mobile banking users in Vietnam. Data were processed using structural equation modeling to evaluate path significance and moderation effects. The empirical results support all hypothesized relationships except for the moderating effect of digital literacy on the path between compatibility and perceived value. The integrated model accounts for 50.4% of the variance in usage intention, demonstrating moderate explanatory power and confirming perceived value as the central driver of adoption. This study contributes to the informatics-service system literature by demonstrating that digital literacy functions as an amplifier of systemic affordances. It highlights that a user's cognitive capability can fundamentally reshape how technological features are translated into net value and behavioral intent, providing a nuanced perspective on technology adoption in transitioning economies.

Keywords: Mobile banking, Technological attributes, Digital literacy, Perceived value, Usage intention

1. Introduction

In the current era of rapid digital transformation, mobile banking in Vietnam has evolved from a supplementary channel into a sophisticated informatics-enabled service system, catalyzed by high smartphone penetration and the State Bank of Vietnam's push for cashless payments. This platform serves as a critical, information-intensive infrastructure that integrates complex data flows, transaction logistics, and service operations within a broader financial ecosystem. As commercial banks invest heavily in features like instant transfers and online investments, the rise of FinTech has shifted the sector toward a service-dominant logic, where success depends on leveraging informatics capabilities, such as real-time processing and secure data integration, to co-create value with the user. Consequently, the expansion of these services among younger, tech-savvy consumers places higher demands on the system's ability to harmonize technological benefits with rigorous security and enhanced user experience.

Previous studies on the intention to use mobile banking services have shown that technology adoption behavior is influenced by many factors related to technological awareness, user psychology, and social context. Based on theoretical models of technology adoption such as Technology Acceptance Model (TAM) (Davis et al., 1989) or Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003), most studies confirm that perceived value plays a significant role in explaining the intention to use mobile banking services (Palamidovska et al., 2024). In addition, usefulness and ease of use are identified as fundamental factors forming a positive perception of technology, thereby directly or indirectly influencing the intention to use by enhancing perceived value (Bouhlel & Mzoughi, 2024). Trust and perceived risk are also considered key factors in the mobile banking landscape, where users face concerns about security and privacy. Studies show that trust can mitigate the negative impact of perceived risk and contribute to strengthening the intention to use (Chauhan, 2024). Finally, technological characteristics such as security, compatibility, and mobility are considered important supporting conditions that enhance the relevance of the service to users' needs and lifestyles, thereby promoting the intention to use (Ivanova, 2022; Lu et al., 2024).

Although technology adoption models such as TAM and UTAUT are widely used in mobile banking research, evidence regarding the direct role of mobile technology characteristics in shaping perceived value remains limited. Characteristics such as compatibility, mobility, and security are often only considered indirectly through usefulness or ease of use, leaving the mechanisms of perceived value formation unclear. Furthermore, digital literacy is rarely considered as a moderating variable, especially in the context of developing economies with significant disparities in digital literacy among user groups. Stemming from these gaps, this study utilizes Innovation Diffusion Theory and the Value-based Adoption Model to explore how systemic affordances - specifically compatibility, mobility, and security - impact the perceived value and adoption intentions of users. Furthermore, this research investigates the moderating role of digital literacy, conceptualizing it as a vital cognitive resource that influences a user's ability to navigate the informatics-driven logistics of the platform. By repositioning mobile banking within an informatics-service system perspective, this paper contributes to the fields of service science and information system governance. It moves beyond traditional acceptance models to articulate how the integration of technological attributes and user competence drives systemic effectiveness. Ultimately, this study provides actionable insights for digital service design and logistics coordination, offering a framework for optimizing the delivery of information-intensive financial services in an increasingly competitive global ecosystem.

2. Literature Review

2.1. Grounded Theories

Innovation Diffusion Theory (IDT) (Rogers, 1995) explains how innovations spread through social systems over time and highlights a set of innovation attributes that influence individuals' adoption decisions. The theory emphasizes that adoption is largely driven by users' subjective perceptions of an

innovation rather than its objective technical features, making it particularly relevant for studying emerging technologies. In recent digital contexts, IDT has been widely applied to examine the adoption of mobile wallets, e-wallet services, and other digital payment technologies, where uncertainty, trust, and perceived usefulness strongly shape user behavior. Prior studies drawing on IDT have shown that favorable perceptions of innovation characteristics can significantly enhance users' willingness to adopt digital payment solutions, especially in environments where traditional payment methods are well established. The theory has also been used to explain differences in adoption rates across user groups by considering how social influence, communication channels, and exposure to early adopters affect diffusion processes. In the context of digital financial services, IDT helps clarify why some technologies achieve rapid market penetration while others face resistance, despite offering similar technical capabilities. Consequently, IDT provides a well-established and empirically supported framework for understanding technology adoption dynamics and serves as a foundational theory for analyzing user acceptance of contemporary digital innovations.

The Value-based Adoption Model (VAM) (Kim et al., 2007) explains technology adoption as a value maximization process in which users assess the trade-off between perceived benefits and perceived sacrifices to form an overall perception of value, which in turn drives their adoption intentions. Rooted in consumer value theory, VAM emphasizes that individuals approach technology adoption decisions in a manner similar to consumption choices, weighing what they gain against what they must give up. Unlike technology acceptance models that focus primarily on cognitive beliefs or attitudes toward system use, VAM places the value calculus at the center of the decision-making process. This perspective is particularly relevant in contemporary digital environments, where users often face multiple competing technologies offering similar functionalities. In such contexts, adoption decisions are influenced not only by functional considerations but also by experiential, emotional, and economic evaluations. Prior research applying VAM has demonstrated its effectiveness in explaining user adoption of mobile services, digital platforms, and online applications, where perceived value serves as a key determinant of behavioral intention. By explicitly incorporating both positive and negative evaluations into a single framework, VAM provides a more balanced and realistic explanation of adoption behavior. Consequently, the model offers strong explanatory power for understanding why users may adopt or reject a technology even when its functional performance is high, highlighting the central role of perceived value in shaping technology adoption decisions.

The theoretical integration of IDT and VAM provides a robust, multi-dimensional framework by positioning structural innovation attributes as the primary antecedents to a user's cognitive benefit-sacrifice calculus. While IDT effectively categorizes the characteristics of an innovation - such as compatibility, mobility and security - it lacks the evaluative depth to explain the rational trade-offs inherent in technology adoption; conversely, VAM excels at modeling the utility-driven decision-making process but offers limited granularity regarding the specific technological drivers of those perceptions. By synthesizing these perspectives, compatibility and mobility are theorized as critical drivers of perceived benefits, facilitating functional alignment and temporal flexibility, while security functions as a vital mechanism for mitigating perceived sacrifices associated with operational risk and cognitive anxiety. This synthesized approach, often visualized through the IDT and VAM framework, establishes a rigorous causal chain that illustrates how systemic affordances are translated into a net value judgment, thereby offering a more comprehensive explanation of adoption intention within informatics-enabled service systems.

2.2. Digital Literacy

Recent literature conceptualizes digital literacy as a single reflective construct, defined as an individual's holistic ability to effectively navigate, evaluate, and utilize digital platforms for financial activities. Unlike a formative model where distinct skills combine to create a construct, a reflective approach assumes that the latent level of a user's digital proficiency is the underlying cause of their observed abilities; thus, a change in overall literacy is manifested through simultaneous shifts in all

measured indicators, such as confidence in managing privacy and ease of interface navigation (Islam & Khan, 2024; T. T. Nguyen et al., 2024). This unidimensional conceptualization is theoretically justified by the high degree of inter-correlation expected between digital skills in mobile banking, where technical and cognitive competencies operate as a unified psychological state of technological readiness (Adel, 2024).By treating digital literacy as a single latent trait, the study achieves greater model parsimony, which is critical when testing complex moderation effects within the IDT-VAM framework (Musyaffi et al., 2024). This ensures that the moderating influence remains statistically robust and interpretable, accurately capturing how a user's singular sense of digital literacy weights the trade-off between technological benefits and perceived sacrifices.

A growing body of empirical research demonstrates that digital literacy has a direct positive effect on users' intention to adopt mobile banking, digital payment systems, and electronic services. Users with higher digital literacy exhibit greater confidence, self-efficacy, and perceived control when interacting with digital platforms, which directly enhances their behavioral intention to use such technologies (Fitriati et al., 2024; Pudin et al., 2025). In addition to its direct influence, digital literacy exerts indirect effects through core perceptual constructs commonly examined in technology acceptance studies. Recent findings show that digitally literate users are more likely to perceive digital financial services as easy to use, useful, and secure, which subsequently strengthens adoption intention (Islam & Khan, 2024; T. T. Nguyen et al., 2024) . These indirect pathways highlight the role of digital literacy in shaping cognitive evaluations that precede acceptance decisions.

Beyond its role as an antecedent, digital literacy has been increasingly examined as a mediating variable that explains how external factors translate into technology adoption outcomes. Studies in FinTech and financial inclusion contexts indicate that digital literacy mediates the relationship between enabling conditions - such as access to digital infrastructure, financial knowledge, and regulatory support - and users' intention to adopt digital financial services (Ha et al., 2025; T. T. Nguyen et al., 2024). In cashless payment ecosystems, digital literacy has been found to mediate the effects of demographic and socioeconomic characteristics on adoption intention by enhancing users' ability to understand system functionality and manage perceived risks (Pudin et al., 2025). These findings suggest that digital literacy serves as a critical mechanism through which structural or contextual factors influence individual-level acceptance behavior.

Recent research also positions digital literacy as a moderator that conditions the strength of relationships within technology acceptance models. Empirical evidence indicates that digital literacy moderates the impact of perceived risk on adoption intention, such that the negative effect of security and privacy concerns is weaker among users with higher digital literacy (T. T. Nguyen et al., 2024). Similarly, studies on digital payment adoption reveal that digital literacy strengthens the positive relationship between trust and behavioral intention, as digitally literate users are better equipped to evaluate platform credibility and security features (Musyaffi et al., 2024). These moderating effects underscore the role of digital literacy as a boundary condition that differentiates how users respond to key acceptance determinants.

Overall, the literature consistently identifies digital literacy as a central construct in understanding technology acceptance in mobile banking, digital payments, and electronic services. It functions not only as a direct predictor of adoption intention but also as an indirect influence, a mediating mechanism, and a moderating factor within acceptance models. These multifaceted roles suggest that digital literacy should be treated as a core explanatory variable rather than a peripheral control. Future research is encouraged to further theorize and empirically test digital literacy within integrated acceptance frameworks, particularly in emerging digital economies where disparities in user competencies remain pronounced.

2.3. Mobile Banking Adoption

Mobile banking services have become a crucial financial transaction channel in the context of the digital transformation of the banking industry. Understanding the factors influencing user intentions has

therefore attracted significant attention from academic research. Based on popular technology adoption models such as TAM and UTAUT, this literature review focuses on analyzing key factor groups including perceived value, utility and ease of use, perceived trust and risk, social influence, and the technological characteristics of mobile banking.

Perceived value is considered the overall assessment by users of the balance between benefits received and costs and risks involved in using mobile banking services. In the context of digital financial services being highly intangible and fraught with risks, recent studies increasingly confirm that perceived value is one of the strongest predictors of usage intention (Palamidovska et al., 2024). Perceived value is formed from external stimuli such as service quality, technological convenience, and usage costs, which then influence psychological states and guide behavioral intentions (Palamidovska et al., 2024). Simultaneously, studies on mobile banking show that perceived value often mediates core cognitive factors such as utility, trust, perceived risk, and intention to use (Rahim et al., 2024). When users perceive benefits that outweigh costs and risks, they tend to form a stronger intention to use mobile banking.

Usefulness and ease of use continue to be affirmed as playing a crucial role in shaping the intention to use mobile banking. Usefulness reflects the extent to which users perceive the service to improve transaction efficiency, save time, and enhance personal financial management, thereby directly promoting the intention to use (Bouhlel & Mzoughi, 2024). Meanwhile, ease of use reflects the simplicity and minimal effort required to operate the application, and often indirectly impacts intention by increasing the perceived usefulness of the system (Frimpong et al., 2020; Trinh et al., 2020). In addition, social influence also plays a significant role in promoting the intention to use, especially in the early stages of mobile banking adoption (Frimpong et al., 2020).

Trust and perceived risk are two closely related and decisive factors in the context of mobile banking. Trust reflects the degree to which users believe in the technology system and the organization providing the service, while perceived risk relates to concerns about finance, security, and privacy (Chauhan, 2024). Many studies indicate that trust positively impacts usage intentions and simultaneously mitigates the negative impact of perceived risk (Trinh et al., 2020). Furthermore, trust mediates between perceived risk and perceived value, as a high level of trust helps users evaluate the overall benefits of the service more positively (Hu et al., 2023).

Furthermore, technological characteristics such as security, compatibility, and mobility are considered important factors influencing the adoption of mobile banking. Security reflects the extent to which users believe the system is capable of protecting data and transactions, while compatibility demonstrates the suitability of the service to individual habits, values, and needs (Lu et al., 2024). Mobility, with the ability to access services anytime, anywhere, is a core advantage of mobile banking over traditional banking. When these characteristics are well met, users tend to increase their trust, appreciate perceived value, and form stronger intentions to use the service (Ivanova, 2022).

The literature review reveals that while technology adoption models like TAM and UTAUT are commonly used in mobile banking research, the direct role of technological characteristics in shaping perceived value remains largely unclear. Many studies only consider characteristics such as compatibility, mobility, and security through mediating variables, leading to inconsistencies in explaining the value creation mechanism. Furthermore, digital literacy is rarely systematically analyzed for its moderating role, even though differences in digital literacy can significantly impact how users perceive benefits and utilize mobile banking services. This gap is particularly pronounced in developing economies, where significant disparities in digital skills exist, highlighting the need for more comprehensive research approaches in this area.

2.4. Research Framework

Mobile banking services have become a crucial financial transaction channel in the context of the digital transformation of the banking industry. Understanding the factors influencing user intentions has therefore attracted significant attention from academic research. Based on popular technology adoption

models such as TAM and UTAUT, this literature review focuses on analyzing key factor groups including perceived value, utility and ease of use, perceived trust and risk, social influence, and the technological characteristics of mobile banking.

The theoretical framework of this study is built on the integration of technology acceptance theories to explain the intention to use mobile banking through the presence of technological characteristics and perceived value, with digital literacy playing a moderating role. Specifically, the proposed model inherits and expands on arguments from IDT, and VAM, emphasizing mobile technology characteristics as important inputs shaping users' perceived value.

According to the IDT, the level of adoption of a technology largely depends on its compatibility with users' needs, habits, and experiences. In the context of mobile banking, compatibility reflects how well the application fits into financial behaviour and digital lifestyles, thereby contributing to enhanced perceived value and encouraging usage intentions. Furthermore, mobility is a core characteristic that differentiates mobile banking from other electronic banking channels. The ability to transact anytime, anywhere offers flexibility and saves time, directly increasing the perceived value of the service. In the research model, mobility is considered an independent technological characteristic that directly impacts perceived value, rather than being implicitly associated with usefulness. Additionally, security plays a crucial role in the digital finance landscape, where risks related to data and fraud are ever-present. When users trust the security of the system, they tend to value the risks less than the benefits, thereby enhancing the overall perceived value of mobile banking services.

In VAM, individuals form perceived value by comparing the benefits received (such as usefulness and convenience) with the associated costs and risks (such as effort, money, and perceived risk). Perceived value plays a crucial mediating role, directly impacting attitudes and intentions to use technology. Unlike traditional models that focus directly on usage intentions, this study suggests that users first form an overall assessment of the value of mobile banking based on technological characteristics and then translate this assessment into a usage intention. This approach aligns with recent research suggesting that perceived value is a comprehensive cognitive mechanism, more fully reflecting the user's decision-making process in a complex digital service environment.

A key theoretical contribution of the proposed model is the integration of digital literacy as a moderating variable. Based on the theory of personal resources and digital literacy (Hobfoll, 2001; Laar et al., 2017), the study argues that the level of digital literacy of users can alter the intensity of the impact of mobile technology characteristics on perceived value. Specifically, users with high digital literacy are more likely to understand the benefits of compatibility and mobility, and more accurately assess the level of system security, thereby translating technology characteristics into stronger perceived value compared to users with low digital literacy.

In summary, the proposed theoretical framework describes a logical chain of relationships: mobile technology characteristics, perceived value, use intention, and digital literacy play a moderating role in the aforementioned relationships. This framework not only expands on existing technology adoption models but also more closely reflects the specifics of mobile banking in the context of digital transformation and the differences in digital literacy among user groups (Figure 1).

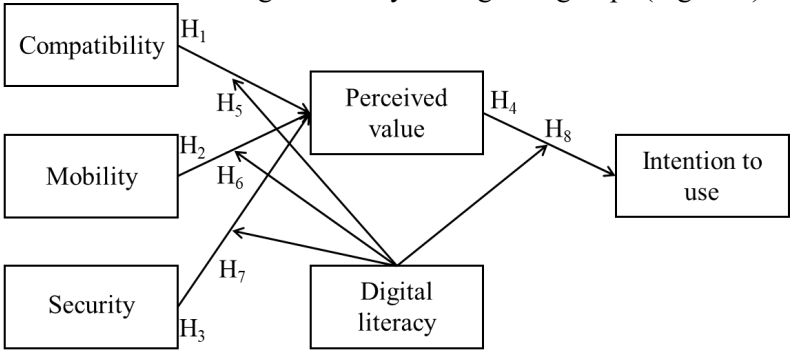

Fig.1: Proposed research model

2.5. Hypothesis Development

In alignment with IDT, compatibility is conceptualized as a mechanism that dictates the cognitive fit between an innovation and the user's socio-cultural values, habits, and existing technological infrastructure (N. H. Nguyen et al., 2024). When a service aligns with a user's lifestyle, it reduces the complexity and uncertainty inherent in the adoption process. Within VAM, this fit directly calibrates the benefit-sacrifice calculus. From a benefit perspective, compatibility maximizes functional utility and convenience; conversely, it minimizes the non-monetary cognitive costs and temporal sacrifices required for system integration. Empirical evidence reinforces that such suitability is positively correlated with enhanced user experiences, as consumers infer higher economic efficiency when a service mirrors their personal financial management style (Palamidovska et al., 2024; Shahid et al., 2022). Consequently, perceived value, the net evaluation of gains versus sacrifices, increases significantly when mobile banking functions as a seamless extension of the user's behavioral patterns (Kıymalıoğlu et al., 2024). Based on this reality, this study proposes the following hypothesis:

H1: Compatibility has a positive impact on perceived value of mobile banking.

From perspective of IDT, mobility is conceptualized as the fundamental affordance enabling ubiquitous access to banking services, characterized by spatial independence and instant operation. Within VAM framework, mobility functions as a primary driver of perceived benefit by enhancing convenience and time-efficiency (Saif et al., 2024). By mitigating the physical sacrifice of traditional branch visits, mobility optimizes the benefit-sacrifice calculus, thereby elevating the overall perceived value of the informatics-service system (Shuleska et al., 2022). Empirical evidence reinforces that this flexible usability is a critical determinant of adoption, as it aligns the service's utility with the mobile lifestyles of modern consumers, fostering a more-gain-than-loss perception (Palamidovska et al., 2024). Based on that reality, this study proposes the following hypothesis:

H2: Mobility has a positive impact on perceived value of mobile banking.

In digital financial services, security is a core attribute because users must exchange sensitive data and conduct transactions with financial risks (Zhang, 2024). Within VAM framework, security functions as a primary mechanism for mitigating perceived sacrifice, specifically the psychological and financial risks associated with data breaches. According to the benefit-risk trade-off, robust security reduces operational risk and fosters trust, thereby increasing the net value users assign to the service (Trinh & Tran, 2025). Empirical research suggests that while security is a baseline expectation, its presence allows users to categorize the experience as trustworthy and worthwhile (Saif et al., 2024). In the benefit-sacrifice calculus, superior security minimizes the cost of anxiety; conversely, its absence significantly inflates perceived sacrifice, undermining the overall value of the informatics-service system (Hu et al., 2023). Based on this, this study proposes the following hypothesis:

H3: Security has a positive impact on perceived value of mobile banking.

In VAM framework, perceived value serves as the primary psychological driver of behavioral intention, representing a synergistic trade-off between perceived benefits and sacrifices. When users determine that mobile banking services offer tangible utility, such as convenience and efficiency, at an acceptable cognitive and financial cost, they develop a robust disposition toward adoption (Shahid et al., 2022). Empirical evidence consistently identifies perceived value as a critical predictor of adoption intention in the digital banking sector (Saif et al., 2024). Furthermore, research highlights that the alignment of positive user experiences with value-driven outcomes directly fosters future behavioral intentions (Ying et al., 2025). By functioning as the ultimate metric for systemic effectiveness, perceived value bridges the gap between technological attributes and the user's final decision-making process (Shuleska et al., 2022). Based on this, this study proposes the following hypothesis:

H4: Perceived value has a positive impact on the intention to use mobile banking.

Digital literacy is the ability to access, understand, and operate digital technology effectively (Hobfoll, 2001; Laar et al., 2017). Within the informatics-service system, digital literacy functions as an amplifier of systemic affordances. Users with high digital literacy experience less technological friction, allowing them to personalize settings and resolve errors independently, which maximizes the

translation of system attributes into perceived value (Adel, 2024). Therefore, with the same level of suitability to their needs, they perceive benefits more clearly and translate this attribute into stronger perceived value (Kabakus et al., 2025; Palamidovska et al., 2024). Studies in mobile banking also note a positive correlation between digital literacy and acceptance levels (Sabila & Hasnawati., 2024). This reinforces the assumption that digital literacy plays an amplifying role in cause-and-effect relationships. Mobility only creates value when users take advantage of flexible transactions, real-time alerts, and optimized device operation; highly digitally literate users excel at these steps, thereby making mobility a greater net benefit and its impact on perceived value stronger (Saif et al., 2024; Shahid et al., 2022). Furthermore, digital literacy recalibrates the benefit-sacrifice calculus regarding security; highly literate users move beyond mere concern to understand structural assurances like multi-factor authentication, perceiving security as a proactive risk-reduction benefit (Saif et al., 2024; Trinh & Tran, 2025). Finally, despite the perceived value of the service, the transformation of perceived value into usage intention still requires digital literacy to execute confident, less error-prone, and less reliant behaviour; therefore, the relationship between perceived value and intention to use mobile banking is expected to be stronger in the high digital literacy group (Kabakus et al., 2025; Saif et al., 2024; Shuleska et al., 2022). Based on this, this study proposes the following hypotheses:

H5: Digital literacy regulates the relationship between compatibility and perceived value; this relationship is stronger for those with high digital literacy.

H6: Digital literacy regulates the relationship between mobility and perceived value; this relationship is stronger for those with high digital literacy.

H7: Digital literacy regulates the relationship between security and perceived value; this relationship is stronger for those with high digital literacy.

H8: Digital literacy regulates the relationship between perceived value and intention to use; this relationship is stronger for those with high digital literacy.

3. Research Methodology

This study employs a quantitative research design to empirically validate the proposed model within the Vietnamese mobile banking context. Given the specificities of this informatics-service system, existing measurement scales were subjected to a rigorous adaptation process following the methodological guidance of Gehlbach and Brinkworth (2011). To ensure linguistic and conceptual equivalence, a formal back-translation procedure was implemented: scales originally sourced from prior studies were translated into Vietnamese and then independently back-translated into English by a second linguist to reconcile any semantic discrepancies.

Supplementing this linguistic rigor, a pilot study was conducted with a panel of ten lay experts - experienced consumers who performed at least one mobile transaction monthly over the previous year. Unlike traditional psychometric validation, this approach focuses on face validity and ecological relevance, leveraging the participants' lived experiences to evaluate the clarity and cultural resonance of the items. Through systematic review sessions, these experts identified potential ambiguities in the informatics-related constructs, allowing for the iterative refinement of wording to match the target population's actual usage context. This dual-layered validation strategy, integrating technical back-translation with consumer-based feedback, ensures that the final instrument is both culturally grounded and technically precise for large-scale deployment.

The main quantitative study was conducted in Ho Chi Minh City, Vietnam, using an online survey administered via Google Forms in an interactive web-based format. The target population consisted of consumers residing in Ho Chi Minh City, and respondents were recruited using a convenience sampling approach. After data screening, a total of 240 valid responses were retained for analysis. These data were used to reassess the measurement model and to test the hypothesized relationships among the research constructs. This study employs Partial Least Squares Structural Equation Modeling (PLS-SEM) rather than Covariance-Based SEM (CB-SEM) due to its methodological advantages. The selection of

PLS-SEM is methodologically justified by the study's causal-predictive objectives and structural complexity. Unlike CB-SEM, which prioritizes parameter consistency for theory testing, PLS-SEM is optimized for maximizing explained variance in endogenous constructs, aligning with this research's goal of identifying key drivers of usage intention. Furthermore, PLS-SEM exhibits superior robustness in estimating complex moderation effects involving digital literacy, avoiding the convergence issues common in CB-SEM. Its non-parametric nature also accommodates potential non-normal data distributions and sample size constraints, ensuring reliable path estimates for this integrated IDT-VAM framework. According to Hair et al. (2022), the minimum sample size for PLS-SEM should be at least five times the number of observed variables. With 24 observed variables, the minimum required sample size is 120. Therefore, the final dataset of 240 responses is sufficient and appropriate for PLS-SEM analysis in this study.

Table 1: Scale of factors in the proposed research model

Code	Factor	Number of observed variables	Original scale
CPA	Compatibility	4	Kıymalıoğlu et al. (2024)
MOB	Mobility	4	Tan et al. (2025)
SEC	Security	4	Abdennebi (2023)
PV	Perceived value	4	Palamidovska et al. (2024)
DLI	Digital literacy	4	Kabakus et al. (2025)
IU	Intention to use	4	Abdennebi (2023)

4. Results and Discussion

4.1. Research Sample

This study sample included 240 participants and was designed to reflect the user group most likely to access and accept mobile banking services in Vietnam (Table 2). In terms of gender, the proportion of men and women was balanced, with men accounting for 52.5% and women 47.5%, indicating that the sample was not significantly skewed by gender. Regarding age, the group under 29 years old accounted for the highest proportion (48.3%), followed by the group aged 29 to 45 (35.8%), reflecting the common characteristic of mobile banking users being the young and middle-aged population. Age groups over 45 accounted for a lower proportion, with the group over 55 years old accounting for only 4.2%.

Regarding marital status, most respondents were married (64.2%), while the single group accounted for 35.8%. In terms of education level, most participants had a university degree (45.0%) and a postgraduate degree (33.7%), indicating a relatively high educational attainment in the study sample, consistent with the context of research on digital banking services. Regarding monthly income, the group with an income of 10 to 18 million VND accounted for the largest proportion (48.3%), followed by the group with an income of 18 to 32 million VND (28.8%), reflecting a relatively high average income level among mobile banking users.

In terms of occupation, the sample distribution was relatively even across groups, with the healthcare, education, and culture sectors accounting for the highest percentage (27.5%), followed by commerce and services (27.1%) and finance and banking (24.2%). Finally, regarding residential areas, most participants came from Ho Chi Minh City (50.0%), Hanoi (27.5%), and Da Nang (17.5%), reflecting the concentration of mobile banking users in major urban areas.

Table 2: Characteristics of the research sample

Characteristic	Count	Frequency	Characteristic	Count	Frequency
Gender			**Age**		
Male	126	52.5%	Under 29	116	48.3%
Female	114	47.5%	From 29 to 45	86	35.8%

Marital Status			From 45 to 55	51	11.7%
Single	86	35.8%	Above 55	10	4.2%
Married	154	64.2%	**Income (monthly)**		
Education			Under $500	53	22.1%
College	51	21.3%	From $500 to $900	116	48.3%
University	108	45.0%	From $900 to $1600	69	28.8%
Postgraduate	81	33.7%	Above $1600	2	0.8%
Occupation			**Area**		
Industry	51	21.2%	Ha Noi City	66	27.5%
Trade, services	65	27.1%	Da Nang City	42	17.5%
Finance, banking	58	24.2%	Ho Chi Minh City	120	50.0%
Health, education	66	27.5%	Other	12	5.0%

In summary, with a demographic structure focused on young, highly educated, and high-income groups, this sample of 240 data points represents the core and potential user group in the Vietnamese mobile banking market, ensuring high relevance for testing the technology adoption model.

4.2. Measurement model validation

Evaluating the measurement model is a fundamental step in ensuring data quality and the validity of research results. According to Hair et al. (2022), the measurement model is evaluated through key criteria: outer loading coefficient, reliability, convergent validity, and discriminant validity. The evaluation results for the 24 observed variables showed that variables CPA4, MOB2, SEC1, and DLI3 have outer loading coefficients less than 0.5; these variables do not contribute significantly to the measurement of the corresponding factor (Hair et al., 2022), and therefore need to be removed from the next analysis step (Table 3).

Table 3: Exploratory factor analysis results

Item	Measurement Statement	Outer loading	
		First evaluation	Second evaluation
Construct: Compatibility (CPA)			
CPA1	Fits well with my personal lifestyle	0.788	0.854
CPA2	Aligns with my personal financial values	0.725	0.823
CPA3	Suits my preferred way of banking	0.727	0.811
CPA4	Matches my existing digital banking habits	0.439	
Construct: Mobility (MOB)			
MOB1	Access banking services from any physical location	0.807	0.809
MOB2	Perform financial transactions immediately at any time	0.345	
MOB3	Manage personal finances flexibly while on move	0.842	0.856
MOB4	Constant service availability via portable mobile devices	0.82	0.82
Construct: Security (SEC)			
SEC1	Ensures high technical reliability for account management	0.425	
SEC2	Provides structural assurance for safe digital transactions	0.776	0.779
SEC3	Reduces anxiety regarding potential data breaches	0.801	0.801
SEC4	Protects financial information from unauthorized access	0.795	0.794
Construct: Perceived value (PV)			
PV1	Provides excellent overall service value	0.756	0.758
PV2	Offers more benefits than potential risks	0.832	0.831
PV3	Benefits outweigh the effort required	0.791	0.79

PV4	Worth the time spent using it	0.801	0.801
Construct: Digital literacy (DL)			
DLI1	Navigate complex mobile banking application interfaces	0.848	0.856
DLI2	Possess necessary skills to manage digital data	0.765	0.765
DLI3	Troubleshoot basic technical banking software issues	0.444	
DLI4	Utilize various advanced digital banking features	0.84	0.837
Construct: Intention to use (IU)			
IU1	Plan to use mobile banking services	0.806	0.806
IU2	Intend to use mobile banking regularly	0.848	0.848
IU3	Will always try to use Mobile banking in my daily life	0.83	0.83
IU4	Will recommend mobile banking to others	0.828	0.828

The second evaluation of the remaining 20 observed variables showed that all observed variables had external loading coefficients greater than 0.7, making a significant contribution to measuring the six factors in the proposed research model. Simultaneously, the results also indicated that these seven factors demonstrated good reliability and validity (Table 3). Specifically, regarding reliability, both key indicators, Cronbach's Alpha (CA) and Composite Reliability (CR), exceeded the required threshold. All CA values were greater than 0.7, demonstrating high internal consistency of the scale. Similarly, CR was also greater than 0.7 across all scales, confirming that the observed variables contributed effectively and consistently to measuring the corresponding latent concepts (Hair et al., 2022).

Table 4: Measurement model test results

Code	Construct	Minimum outer loadings	CA	CR	AVE	Maximum outer VIF values
CPA	Compatibility	0.811	0.773	0.869	0.688	1.710
MOB	Mobility	0.809	0.771	0.868	0.686	1.773
SEC	Security	0.779	0.702	0.834	0.626	1.457
PV	Perceived value	0.758	0.806	0.873	0.633	1.808
DLI	Digital literacy	0.765	0.758	0.86	0.673	1.663
IU	Intention to use	0.806	0.771	0.867	0.686	1.675

Next, testing for convergent validity through the Average Variance Extracted (AVE) shows that the study's measurement model meets the requirements. Analysis of the results shows that all factors have an AVE greater than 0.5. The lowest AVE value is 0.626 (SEC), which is still significantly higher than the threshold of 0.5. This confirms that at least 50% of the variance of the observed variables is explained by latent factors, and the observed variables within each factor have converged to measure the effectiveness of a single concept (Hair et al., 2022). The combination of CR > 0.7 and AVE > 0.5 is strong evidence for the quality of the measurement, confirming the intrinsic validity of the structures (Table 4).

Table 5. Fornell - Larcker Correlation Index

	CPA	DLI	IU	MOB	PV	SEC
CPA	0.830					
DLI	0.164	0.820				
IU	0.442	0.358	0.828			
MOB	0.311	0.264	0.475	0.828		
PV	0.457	0.271	0.675	0.626	0.795	
SEC	0.189	0.261	0.482	0.256	0.300	0.791

Finally, the Fornell-Larcker criterion is a traditional method used in PLS-SEM to assess discriminant validity, ensuring that a latent construct shares more variance with its own assigned indicators than with any other construct in the structural model. To satisfy this criterion, the square root of the AVE for each construct must be greater than its highest correlation with any other latent variable (Table 5). The fact that all square root of the AVE values met the requirements confirms that the latent factors used in the model are not duplicated, but actually represent distinct concepts (Hair et al., 2022).

4.3. Structural model validation

The research model demonstrated no serious multicollinearity issues at both the measurement and structural levels. At the measurement level, testing via the largest external VIF showed that all factors had VIF values in the low range, far from the warning threshold (Table 3). This confirms the independence and reliability of the observed variables when measuring the corresponding latent factor. At the structural level, the assessment via the intrinsic VIF also yielded very good results, with all VIF values ranging only between 1.001 and 1.369 (Table 6). Since all VIF values at both levels are below the threshold of 5 and close to 1, it ensures that the regression coefficients estimated in the structural model are stable and reliable (Hair et al., 2022). Furthermore, since all inner and outer VIF values are less than 3.3, the model does not exhibit common method bias as noted by Kock (2015).

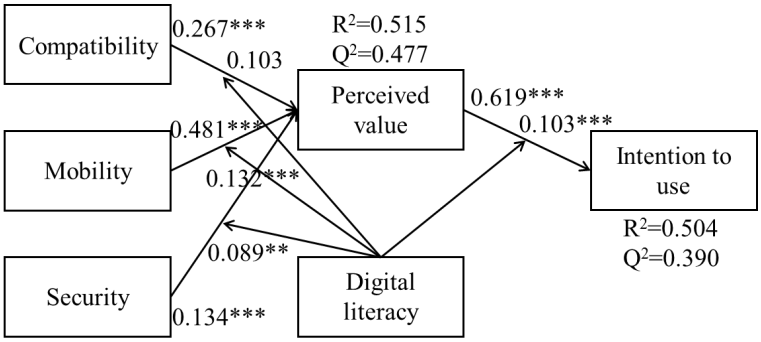

Fig.2: PLS-SEM results

The research results show that in the context of mobile banking services, MOB is the factor with the strongest impact on PV ($\beta = 0.481$; $p < 0.001$, $f^2 = 0.39$). Besides that, CPA also has a positive and statistically significant influence on PV ($\beta = 0.267$; $p < 0.001$). Furthermore, SEC also has a positive impact on PV ($\beta = 0.134$; $p = 0.002$). The analysis also indicates that PV has a very strong and positive influence on IU ($\beta = 0.619$; $p < 0.001$), with a large effect size ($f^2 = 0.716$). Hypotheses H1-H4 are supported. Regarding the moderating role of DLI, the results showed that DLI did not significantly moderate the relationship between CPA and PV ($\beta = 0.103$; $p = 0.068$), thus hypothesis H5 was not supported. However, DLI had a statistically significant moderating effect on the relationship between MOB and PV ($\beta = 0.132$; $p = 0.009$), between SEC and PV ($\beta = 0.089$; $p = 0.043$), and between PV and IU ($\beta = 0.103$; $p = 0.008$). Hypotheses H6-H8 were supported (Table 6).

Table 6: Structural model evaluation results

	Hypothesis	Co-efficient	P-value	Result	Inner VIF	f^2	Effect
H1	CPA -> PV	0.267	0	Accepted	1.145	0.128	Small
H2	MOB -> PV	0.481	0	Accepted	1.226	0.39	Medium
H3	SEC -> PV	0.134	0.002	Accepted	1.167	0.032	Small
H4	PV -> IU	0.619	0	Accepted	1.080	0.716	Strong
H5	DLI x CPA -> PV	0.103	0.068	Declined	1.279	0.021	Small
H6	DLI x MOB -> PV	0.132	0.009	Accepted	1.281	0.032	Small

H7	DLI x SEC -> PV	0.089	0.043	Accepted	1.369	0.016	Very small
H8	DLI x PV -> IU	0.103	0.008	Accepted	1.001	0.031	Small

The path analysis results in Table 7 show that all three indirect paths are statistically significant at the $p < 0.05$ level, confirming that PV serves as a critical bridge between technological attributes and adoption behavior. Specifically, the strongest indirect effect flows from MOB ($\beta = 0.298$, $p < 0.001$), followed by CPA ($\beta = 0.165$, $p < 0.001$), while SEC ($\beta = 0.083$, $p = 0.003$) exerts a significant but comparatively smaller influence. These results provide the necessary empirical evidence to move beyond a descriptive synthesis, formally establishing the causal chain where innovation characteristics drive adoption by first enhancing the user's perceived value proposition.

Table 7: Path Analysis Results

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
CPA -> IU	0.165	0.165	0.040	4.104	0.000
MOB -> IU	0.298	0.298	0.040	7.432	0.000
SEC -> IU	0.083	0.084	0.028	2.952	0.003

The analysis results show that the model has a fairly good explanatory power for PV and IU (Figure 2). Specifically, the R^2 coefficient of PV reached 0.515 and that of IU reached 0.504, indicating that the independent variables in the model explain about 50% of the variation of each concept. According to Hair et al. (2022), this is a moderate to good explanatory power and is considered appropriate for studies in the fields of social science and consumer behavior. In addition, the adjusted R^2 value is close to the original R^2, indicating that the model is stable and not significantly affected by the number of variables.

The predictive power of the model was assessed through the Q^2 index and yielded positive results (Figure 2). The Q^2 value of PV reached 0.477 and that of IU reached 0.390, both greater than 0, confirming the model's predictive value. According to Hair et al. (2022), these values reflect a medium to high predictive power, especially for PV. This indicates that the model not only explains the relationships in the study sample well but also has reliable predictive power for new observations, thereby enhancing the practical significance of the research results.

4.4. Discussion

The structural model test results show that all hypotheses are supported, except for the moderation of digital literacy on the relationship between compatibility and perceived value, confirming the model's fit and the positive causal relationship between the factors. The model also demonstrates average explanatory power for usage intentions, suggesting that the proposed technological and emotional factors play a significant role in driving mobile banking usage behavior.

The empirical results indicate that perceived value exerts a dominant and statistically significant influence on the intention to use mobile banking services, confirming its status as the primary determinant of adoption (Bouhlel & Mzoughi, 2024). This finding underscores a fundamental shift in user behavior within competitive financial ecosystems, where usage decisions are driven by a rigorous benefit-sacrifice calculus rather than mere feature availability. In this context, perceived value acts as the decisive psychological "tipping point" that bridges cognitive evaluation with behavioral intent (Ying et al., 2025). By integrating benefits, such as accessibility and efficiency, against perceived costs like effort and risk, users form a singular value judgment that dictates their willingness to adopt (Rahim et al., 2024). The substantial magnitude of this relationship suggests that perceived value is not merely a passive intermediary; rather, it is the central engine of the decision-making process. In an era of intensifying competition and service ubiquity, the ability of a platform to generate a superior net-value perception becomes the critical strategic differentiator for banks seeking to secure long-term customer

engagement and foster a more-gain-than-loss assessment (Palamidovska et al., 2024).

Among the technological factors examined in this study, mobility emerged as the most influential determinant of perceived value. This result is consistent with prior research emphasizing that the ability to access banking services anytime and anywhere represents a fundamental advantage of mobile banking platforms (Ivanova, 2022). The strong effect of mobility reflects an ongoing transformation in user expectations; whereby temporal and spatial flexibility have become essential criteria in users' evaluation of digital financial services. As modern consumers increasingly manage their financial activities in dynamic and mobile contexts, the perceived value of mobile banking is significantly enhanced when services seamlessly support on-the-go usage (Lu et al., 2024). Compatibility also demonstrated a positive and statistically significant relationship with perceived value. This finding indicates that when mobile banking services align well with users' existing lifestyles, routines, and technological habits, the perceived effort required to adopt and use such services is reduced. Consequently, psychological resistance and cognitive friction are minimized, allowing users to focus more on the benefits delivered by the service (Frimpong et al., 2020). However, the moderate magnitude of this effect suggests that compatibility functions primarily as a baseline or enabling condition rather than a strong value differentiator. In a context where mobile banking has become increasingly widespread and technologically standardized, users may implicitly expect compatibility as a given feature rather than a source of added value. Security, while positively associated with perceived value, exhibited a comparatively weaker effect. This result aligns with recent literature suggesting that security is gradually transitioning from a value-creating attribute to a hygiene factor in digital banking services (Chauhan, 2024). As robust security mechanisms become standardized across platforms, users tend to assume a minimum acceptable level of protection. Consequently, security only becomes salient when it is inadequate or compromised. When security is perceived as sufficient and reliable, users shift their evaluative focus toward more tangible and experiential benefits, such as convenience, efficiency, and service functionality, in forming their overall value perception (Zhang, 2024).

The empirical findings indicate that digital literacy does not moderate the relationship between compatibility and perceived value. This result suggests that users tend to evaluate the degree to which mobile banking services align with their lifestyles, routines, and technological habits in a relatively consistent manner, regardless of their level of digital literacy. Compatibility appears to function as an intuitive and experiential assessment, requiring minimal technical literacy to evaluate. Once a service fits seamlessly into users' daily activities, its relevance is readily recognized by both digitally proficient and less digitally skilled users alike, supporting prior findings by (Frimpong et al., 2020). In contrast, digital literacy was found to positively moderate the relationships between mobility and security with perceived value. This indicates that users with higher levels of digital literacy are better equipped to recognize, utilize, and extract value from the functional advantages offered by mobile banking, particularly its anytime-anywhere accessibility. Digitally literate users are more capable of navigating advanced features, managing multiple usage contexts, and optimizing mobile banking services to suit their personal and professional needs. As a result, the mobility of mobile banking contributes more strongly to perceived value for this user group. Similarly, the moderating effect of digital literacy on the relationship between security and perceived value highlights the role of user competence in interpreting and trusting technological safeguards. Users with higher digital literacy are more likely to understand security mechanisms such as encryption, authentication protocols, and fraud prevention tools. This understanding reduces perceived uncertainty and enhances confidence in the platform, thereby strengthening the positive impact of security on perceived value (Chauhan, 2024). Furthermore, the results demonstrate that digital literacy amplifies the relationship between perceived value and intention to use mobile banking services. This suggests that digitally literate users are more adept at converting favorable value perceptions into concrete behavioral intentions. Their familiarity with digital technologies lowers adoption barriers and increases their willingness to act on perceived benefits. However, it is essential to note that while these moderation effects are statistically significant, the

observed effect sizes are practically modest. This indicates that while digitally literate users are slightly better equipped to navigate advanced features, interpret security protocols like encryption, and convert value perceptions into behavioral intentions, digital literacy serves as a subtle facilitator rather than a dominant driver of the adoption calculus. Consequently, while the results support digital literacy as a statistically valid enabling factor, its low substantive impact suggests that the core technological attributes of the service itself remain the primary determinants of perceived value for the broader user base.

5. Conclusion

This study examines the impact of three core technological characteristics, including compatibility, mobility, and security, on perceived value and the subsequent intention to use mobile banking services, while assessing the moderating role of digital literacy. By prioritizing a parsimonious model focused on the functional and cognitive trade-offs inherent in the IDT-VAM nexus, the research isolates the most significant technological features that inform the user's evaluative state, ensuring that the influence of digital literacy is evaluated with theoretical coherence. Utilizing a quantitative methodology with 240 valid responses, the results provide empirical support for all proposed hypotheses, with the notable exception of the moderating role of digital literacy in the relationship between compatibility and perceived value. Overall, the model demonstrates moderate explanatory power, accounting for 50.4% of the variance in usage intention within the Vietnamese emerging market context.

This study contributes to the digital banking literature by empirically validating the integrated IDT-VAM framework within Vietnam's emerging market, repositioning mobile banking as a sophisticated informatics-enabled service system. Rather than proposing a fundamental theoretical breakthrough, the research reconfigures established constructs to demonstrate that perceived value functions as the primary psychological mechanism synthesizing benefits and sacrifices into a unified metric for systemic effectiveness. The findings clarify the differentiated roles of systemic affordances, revealing that mobility and compatibility are not merely technical features but essential drivers that optimize service operations and deliver immediate convenience. Conversely, security is shown to function as a fundamental governance mechanism that, while essential for system integrity, acts as a hygiene factor rather than an independent driver of incremental value. By confirming that adoption is a function of how effectively digital infrastructure integrates transaction logistics and data flows to co-create value, this research offers a grounded application of value-based logic to a transitioning financial ecosystem, shifting the focus from isolated technological perceptions to the holistic optimization of the digital service ecosystem.

The findings of this study offer several important practical implications for banks and mobile banking service providers in the design, development, and management of mobile applications. First, since perceived value is the primary driver of intention, banks should implement "micro-moment engineering within the user interface, applying a "three-tap rule" to ensure core functions like balance inquiries and peer-to-peer transfers are accessible within three interactions. To operationalize mobility, developers must utilize predictive caching and offline-mode queuing, allowing the application to remain functional under low-bandwidth conditions and automatically synchronize transactions once connectivity is restored. Regarding security, instead of relying on intrusive multi-factor authentication that increases cognitive friction, providers should deploy behavioral biometrics, such as keystroke dynamics and touch-pressure analysis, to provide invisible security layers that maintain safety without compromising the user experience. The moderating role of digital literacy necessitates a data-driven segmentation strategy. Banks should use machine learning to calculate a digital proficiency score for each user based on app navigation patterns and help-desk interactions. For low literacy segments, the bank should offer a lite interface mode that prioritizes simplified language and larger touch targets, while the high literacy segment is targeted with advanced FinTech features like automated investment portfolios. To proactively bridge the literacy gap, banks should replace external manuals with

contextual nudges and Just-in-Time tutorials, AI-driven walkthroughs that activate only when a user hesitates during a complex task. Furthermore, cybersecurity measures should be tailored through adaptive security levels, where AI-driven cool-off periods and simplified fraud warnings are triggered for users with lower literacy to reduce anxiety and build trust. Finally, banks should integrate gamified financial fitness modules, rewarding users with loyalty points or fee waivers for completing 30-second interactive security drills. By transitioning from a one-size-fits-all approach to these specific, technology-enabled tactics, mobile banking providers can effectively lower the perceived sacrifice and amplify the perceived value for diverse user groups, ultimately securing long-term behavioral loyalty in a competitive digital ecosystem.

Despite providing empirical insights into the Vietnamese digital service ecosystem, this study has several limitations that offer pathways for future research. First, the data were primarily collected from three major urban centers, which may limit the external validity of the findings across rural regions where digital infrastructure and financial accessibility differ significantly. Future studies should employ comparative designs to test if these causal paths hold in areas with lower digital penetration. Second, the cross-sectional nature of the research captures a single point in time, failing to account for the dynamic evolution of user perceptions as they gain experience. Longitudinal research is encouraged to examine how value co-creation and usage intentions shift over the long-term adoption lifecycle. Third, while the model focuses on technological attributes and value, it does not incorporate other systemic factors such as trust, switching costs, or social influence, which are critical in competitive financial markets. Integrating these constructs would provide a more holistic view of the informatics-service system. Finally, digital literacy was measured as a composite construct, potentially obscuring the nuanced effects of specific dimensions like technical skill or security awareness. Disaggregating these components in future models would enhance the precision of information system governance strategies by identifying which specific competencies most effectively moderate the relationship between system affordances and perceived value.

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