

Toward a behavioral framework for virtual banking adoption: A systematic review integrating trust, risk, digital literacy, and innovativeness in emerging economies



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Abstract Virtual banking is reshaping financial services in emerging economies, yet adoption remains uneven despite widespread technological readiness. This study aims to synthesize current evidence on the behavioral foundations of virtual banking adoption, focusing on trust, perceived risk, digital literacy, and consumer innovativeness. A systematic literature review was conducted in accordance with the PRISMA 2020 guidelines, drawing on peer-reviewed journal articles published between 2020 and 2025 across four major academic databases. Eight studies meeting rigorous inclusion criteria were analyzed using descriptive mapping and thematic synthesis. The findings demonstrate that trust is the most consistent and influential driver of virtual banking adoption, while perceived risk, particularly related to data security and privacy, remains the strongest barrier. Digital literacy enhances users' confidence and perceived control, thereby reducing uncertainty and facilitating engagement with digital-only financial services. Consumer innovativeness encourages exploratory behavior and early adoption, but its effect is contingent upon the presence of institutional credibility and regulatory assurance. Overall, the evidence suggests that adoption in emerging economies depends less on technological capability alone and more on users' behavioral confidence shaped by psychological, social, and institutional conditions. Building on these insights, the study proposes a Behavioral Confidence Framework that conceptualizes virtual banking adoption as a dynamic process driven by confidence, competence, and curiosity. Confidence emerges when trust outweighs perceived risk, competence reflects users' digital capability and self-efficacy, and curiosity captures the motivation to explore and sustain engagement with novel financial technologies. This framework extends traditional technology acceptance models by embedding behavioral depth and contextual sensitivity relevant to emerging economies. The findings offer practical guidance for policymakers and fintech providers seeking to design trust-centric, literacy-driven, and innovation-enabled virtual banking ecosystems that promote financial inclusion and sustainable digital transformation across Asia.

Keywords: consumer confidence, fintech readiness, perceived security, financial service innovation, digital financial ecosystems, developing markets

1. Introduction

The global banking industry is undergoing a profound transformation driven by digitalization, changing consumer expectations, and the rapid diffusion of financial technologies (Murshudli & Loguinov, 2019; Panfil & Cristafovici, 2024; Sloboda & Demianyk, 2020). Over the past decade, virtual banks—also referred to as neobanks, challenger banks, or digital-only banks—have emerged as powerful disruptors of conventional banking systems (Law, 2024; Liao et al., 1999). These institutions operate without physical branches, relying instead on mobile and online platforms to deliver customer-centric, data-driven, and low-cost financial services (Sha & Mohammad, 2017). Globally, this paradigm shift is reshaping how individuals access, manage, and perceive financial value, leading scholars and regulators alike to reconceptualize the foundations of trust, risk, and innovation in the financial sector (Mishchenko et al., 2021; Salamopsis et al., 2014; Vasiliu-Feltes, 2024).

While virtual banking adoption has accelerated in developed markets such as Europe, North America, and Australia, the momentum in emerging economies has been comparatively uneven (Lockett & Holland, 1996; Schatt, 2014; Tkachenko, 2020). These markets face distinctive challenges that include financial exclusion, limited digital skills, regulatory uncertainty, and socio-cultural resistance (Nguyen & McCahery, 2020). Yet, they also represent the most promising frontiers for digital financial inclusion. The World Bank estimates that over 1.4 billion adults globally remain unbanked, with the majority located in Asia and Africa (Jain & Sahu, 2025). In this context, virtual banking is not merely a technological innovation; it has become a socio-



economic instrument for advancing inclusive growth, reducing transaction inequality, and fostering entrepreneurial participation.

Across Asia, the rise of virtual banking is deeply intertwined with the region's fintech revolution. Economies such as Hong Kong, Singapore, South Korea, and Malaysia have already issued digital banking licenses to foster competition and promote inclusive finance (Barquin & Vinayak, 2015; Mueller, 2021). The region's demographic composition, young, digitally connected, and a mobile-first population has created fertile ground for financial innovation. Nevertheless, adoption dynamics remain complex. Asian consumers tend to exhibit high uncertainty avoidance and rely heavily on institutional trust when engaging with financial technologies (Cainey, 2014; Kowsar et al., 2025). The coexistence of technological optimism and perceived vulnerability creates a paradox that demands a behavioral explanation beyond conventional technology acceptance models.

Within the national and local contexts, countries like Thailand, Vietnam, and Indonesia illustrate both the promise and fragility of digital banking ecosystems. In Thailand, for instance, the Bank of Thailand's 2023 announcement of virtual bank licensing is expected to reshape retail financial competition, particularly among digitally literate but trust-sensitive users (Kaewnin, 2024; Kraiwant et al., 2024). Despite the government's digital economy roadmap and extensive mobile penetration, a significant segment of the population remains hesitant to shift from traditional to virtual banking platforms due to concerns over data privacy, financial security, and perceived service reliability (Liao et al., 1999; Schatt, 2014). Similar patterns are observed in other ASEAN economies, where digital literacy, risk perception, and consumer innovativeness collectively determine adoption trajectories (Barquin & Vinayak, 2015; Nguyen & McCahery, 2020).

From a theoretical standpoint, most prior studies on financial technology adoption have drawn upon models such as the Technology Acceptance Model (Davis, 1989), Unified Theory of Acceptance and Use of Technology (Venkatesh et al., 2003), and Diffusion of Innovation (DOI) (Rogers et al., 2014). While these models successfully explain utilitarian perceptions—such as usefulness and ease of use—they inadequately capture the psychological and contextual variables unique to digital-only financial services. For instance, trust remains an essential determinant of consumers' willingness to engage with intangible, algorithm-driven institutions, while perceived risk often mediates or moderates that relationship (Banker & Khetani, 2019). Equally, digital literacy shapes users' self-efficacy and ability to evaluate online information, whereas consumer innovativeness influences their openness to technological experimentation (Alalwan et al., 2018b; Parasuraman & Colby, 2015). Despite their relevance, these constructs are rarely integrated into a single behavioral model of virtual banking adoption—particularly in emerging economies, where social, cultural, and institutional dynamics intersect.

Hence, there remains a significant knowledge gap in understanding how these behavioral dimensions interact to shape consumers' intention to adopt virtual banking (Chan et al., 2025; Khan et al., 2017). Existing studies often analyze trust and risk independently, overlooking how literacy and innovativeness may mitigate or amplify their effects (Kaur & Arora, 2021). Furthermore, empirical research on virtual banking is heavily concentrated in technologically advanced markets, leaving limited insights applicable to developing or transitional economies in Asia (Mueller, 2021). This gap hinders both theoretical development and policy formulation aimed at achieving inclusive and sustainable financial transformation.

To address these limitations, the present study undertakes a Systematic Literature Review (SLR) of peer-reviewed research published between 2020 and 2025 on virtual banking adoption and related behavioral constructs. This review seeks to (1) map the evolution of behavioral research in virtual banking, (2) identify how trust, perceived risk, digital literacy, and innovativeness have been conceptualized and measured, and (3) synthesize their interrelationships into an integrative behavioral framework suited to emerging economies. The research is guided by four questions:

RQ1 What behavioral factors influence consumers' adoption of virtual banking in emerging economies?

RQ2 How have trust, perceived risk, digital literacy, and innovativeness been conceptualized and measured in prior studies?

RQ3 What theoretical and methodological approaches dominate virtual banking research?

RQ4 What gaps and directions emerge for building an integrated behavioral framework?

This research contributes to both academic and practical domains. Theoretically, it extends technology adoption paradigms by embedding behavioral, psychological, and contextual constructs into the discourse of virtual banking. Methodologically, it provides a transparent and replicable synthesis using the PRISMA framework. Practically, the findings inform policymakers and financial institutions in Asia on strategies to enhance consumer trust, reduce perceived risk, and promote digital literacy and innovation-friendly environments. Ultimately, the review aspires to build a foundation for an Asian-centric behavioral framework that reflects the socio-cultural realities of digital financial transformation in emerging economies.

2. Materials and Methods

This study adopted a Systematic Literature Review (SLR) approach to synthesize and evaluate current research on virtual banking adoption with a particular focus on behavioral determinants, including trust, perceived risk, digital literacy, and innovativeness in emerging economies. The review followed the PRISMA 2020 framework, integrating procedures (Page et al., 2021; Templier & Paré, 2015) to ensure transparency, replicability, and methodological rigor.

2.1. Review design

A systematic review was selected to capture and analyze dispersed findings across interdisciplinary domains such as finance, management, economics, and digital technology. This method allows the researcher to identify theoretical consistencies, methodological variations, and research gaps more effectively than a narrative review. The review process consisted of four sequential phases: identification, screening, eligibility, and inclusion. Each stage applied explicit criteria to minimize selection bias. All articles were independently screened and cross-verified by two reviewers to maintain consistency and reduce interpretive subjectivity.

2.2. Search strategy

The literature search was conducted across four academic databases: Scopus, JSTOR, ASEAN Citation Index (ACI), and Thai Citation Index (TCI). These sources were selected to balance global and regional coverage: Scopus provides broad international indexing in business, management, and information systems; JSTOR adds access to interdisciplinary behavioral scholarship; ACI captures Southeast Asian research; and TCI reflects local perspectives relevant to Thailand’s virtual banking context. To ensure comprehensive coverage of both technological and behavioral dimensions of virtual banking adoption, the search strategy combined keywords related to virtual banking with terms capturing adoption intention and behavioral determinants.

This approach was designed to retrieve studies addressing not only system usage but also psychological and contextual factors influencing consumer adoption. Accordingly, the following Boolean query was applied: (virtual bank OR neobank* OR digital-only bank* OR challenger bank* OR branchless bank*) AND (adoption OR acceptance OR intention to use OR behavioral intention OR technology acceptance) AND (trust OR risk OR security OR privacy OR literacy OR capability OR innovativeness OR motivation)*

The time frame was 2020–October 2025. This stringent time restriction was established because virtual banking is a nascent topic undergoing rapid development, with significant regulatory and market advancements primarily occurring after 2020. This limitation ensures the review focuses solely on the most contemporary and relevant behavioral research, thereby enhancing the applicability of the proposed framework. Only English-language, peer-reviewed journal articles were included; non-English items, conference papers, theses, and non-academic materials were excluded. Note: The asterisk (*) indicates truncation to capture word variants (e.g., neobank, neobanks, neobanking)*.

2.3. Inclusion and exclusion criteria

The inclusion and exclusion criteria were established to ensure that only relevant, high-quality studies addressing the behavioral aspects of virtual banking adoption were retained. These criteria were designed to maintain methodological rigor, conceptual relevance, and consistency across the selected literature. As shown in Table 1, the screening process prioritized recent, peer-reviewed journal articles published in English between 2020 and October 2025, with a clear focus on behavioral determinants within business and social science disciplines.

Table 1 Inclusion and exclusion criteria.

Criterion	Inclusion	Exclusion
Publication Period	2020–October 2025	Studies published before 2020
Language	English only	Non-English records
Peer Review	Journal articles from peer-reviewed sources	Non-peer-reviewed papers
Disciplinary Scope	Business, management, economics, finance, decision science, and social sciences	Engineering, policy, or technical-only studies
Access and Type	Open-access or full-text available empirical and conceptual studies	Full texts not available or incomplete
Focus	Behavioral aspects of virtual banking adoption	Conceptual or organizational perspectives without behavioral focus

2.4. Screening and selection process

The multi-database search initially identified 254 records, comprising 50 from Scopus, 5 from the ASEAN Citation Index, 2 from the Thai Citation Index, and 197 from JSTOR. After removing 198 duplicate records and studies published before 2020, 56 records remained. Restricting the dataset to English-language, peer-reviewed journal articles further reduced the number to 34 studies.

Subsequent subject-area filtering, limited to business, management, economics, finance, decision science, and social sciences, resulted in 28 studies. Of these, 16 open-access articles were retained for full-text assessment. During this stage, 12



records were excluded due to the unavailability of full-text access, a necessary step to ensure methodological rigor and to base the synthesis solely on fully verifiable evidence. Following title-and-abstract screening, an additional five studies were excluded because their primary focus was conceptual or organizational rather than behavioral, which fell outside the scope of the proposed Behavioral Confidence Framework. As a result, a final total of eight studies met all inclusion criteria and were retained for synthesis. The complete screening and selection process is illustrated in Figure 1.

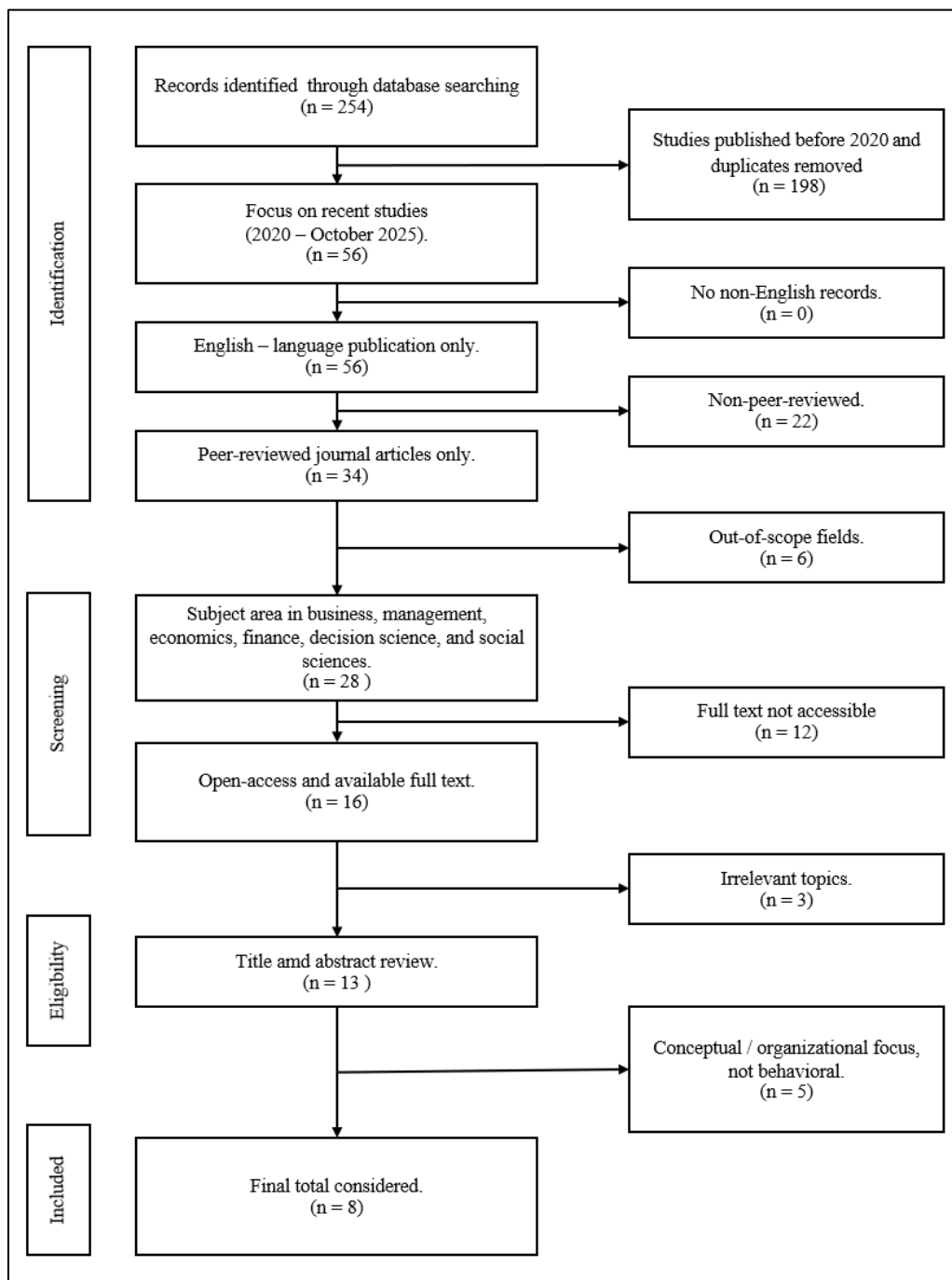


Figure 1 PRISMA flow diagram.

2.5. Data extraction and analysis

Each of the 8 studies was systematically coded by author, year, country, theoretical framework, research method, and key behavioral findings. Data extraction was organized into two dimensions: descriptive analysis and thematic synthesis.

The descriptive phase summarized publication patterns, regional distribution, and theoretical approaches. The thematic synthesis identified four recurring themes of trust, risk, literacy, and innovativeness that collectively shape consumer intention toward virtual banking. Through iterative coding and comparison, these themes were integrated into a conceptual framework highlighting the interrelationships among psychological and contextual determinants of adoption.



2.6. Quality appraisal and limitations

A quality appraisal was conducted to ensure methodological integrity and theoretical relevance. Each study was evaluated on clarity of objectives, rigor of data collection, analytical depth, and relevance to behavioral theory, using a five-point scale. Only studies scoring above three were retained.

Despite the structured process, certain limitations remain. The focus on English-language publications may have excluded valuable regional research in local languages. The reliance on four major databases could omit emerging work from non-indexed sources. It is noted that the final inclusion of only 8 studies is a direct result of the highly stringent, behavioral-focused criteria applied. This limited number reflects the precision and depth of the review, prioritizing studies that explicitly address consumer psychology in the context of virtual banking adoption over the sheer quantity of literature available. Nonetheless, the review process provides a transparent and comprehensive synthesis of the behavioral literature on virtual banking adoption in emerging economies.

3. Results and Discussion

3.1. Results

3.1.1. Overview of included studies

Eight peer-reviewed journal articles published between 2020 and 2025 were included in the final analysis. As illustrated in Figure 1, the selected studies represented both developed and emerging economies, with a strong concentration in Asia, including Thailand, Malaysia, Indonesia, and other regional contexts. Quantitative approaches predominated, particularly studies employing structural equation modelling to examine behavioral intention toward virtual banking adoption. In addition, one study applied text mining and sentiment analysis, while another proposed a conceptual framework for born-digital firms.

As summarized in Table 2, most of the included studies were grounded in established technology adoption theories, notably the Technology Acceptance Model and the Unified Theory of Acceptance and Use of Technology. These frameworks were commonly extended with behavioral variables such as perceived risk, trust, and social influence. Across the reviewed literature, recurring constructs included perceived usefulness, ease of use, trust, perceived risk, consumer innovativeness, and digital literacy, highlighting the multidimensional determinants shaping virtual banking adoption across diverse cultural and technological contexts.

The reviewed studies draw heavily on established technology adoption theories, particularly TAM and UTAUT, as their primary analytical foundations. Technology adoption research provides several theoretical foundations for studying virtual banking. The Technology Acceptance Model (Davis, 1989) identifies perceived usefulness and perceived ease of use as key predictors of behavioral intention. The Unified Theory of Acceptance and Use of Technology (Venkatesh et al., 2003) adds social influence and facilitating conditions. Other frameworks, such as the Theory of Planned Behavior (Ajzen, 1991) and the Diffusion of Innovation theory (Rogers et al., 2014), include attitudinal and personality-based determinants of acceptance.

However, the synthesis highlights that these models are insufficient when applied to digital financial services that involve high levels of uncertainty and institutional dependence. While these models remain influential, they were designed for general technological innovations rather than financial technologies involving trust, security, and institutional oversight. Financial technologies are distinctive because users make decisions involving money, privacy, and long-term relationships with service providers. Psychological assurance and perceived risk can therefore outweigh convenience or efficiency (Gefen et al., 2003; McKnight et al., 2011). Recent research has expanded these theories to include behavioral constructs such as trust, perceived risk, digital literacy, and innovativeness (Alalwan et al., 2018b, 2018c).

Table 2 Overview of included studies (2020–2025).

No.	Title	Country / Region	Methodology	Framework	Key Constructs	Major Findings
1	Virtual banks and the perceived risk and development and effort expectancy on behavioral intention (Mangini et al., 2020)	Brazil	Quantitative (Survey, SEM–PLS, n=271)	UTAUT with Perceived Risk	Performance Expectancy, Effort Expectancy, Perceived Risk, Behavioral Intention	Performance and effort expectancy positively affected behavioral intention, while perceived risk had a significant negative effect. Communication and trust-building reduce risk perception.



2	Born digitals: Thoughts on their internationalization and a research agenda (Monaghan et al., 2020)	ASEAN & Global	Conceptual / Commentary	Johanson & Vahlne Internationalization Process	Digitalization, Network Effects, Scalability, Stakeholder Engagement	Proposed that born-digital firms internationalize rapidly through digital affordances (automation, network effects, scalability), redefining trust and internationalization mechanisms.
3	Determinants of the intention to adopt digital-only banks in Malaysia (Saif et al., 2022)	Malaysia	Quantitative (Survey, SEM, n≈300)	TAM + Trust	Perceived Usefulness, Ease of Use, Trust, Attitude, Intention	All TAM constructs significantly influenced adoption intention; trust mediated the link between usefulness and behavioral intention.
4	Customer adoption of neobank services from a technology acceptance perspective—evidence from Hungary (Nagy et al., 2024)	Hungary	Quantitative (Survey, n≈400, SEM)	Extended TAM–UTAUT	Perceived Usefulness, Ease of Use, Trust, Risk, Social Influence	Usefulness and social influence most strongly predicted adoption; perceived risk reduced trust and intention; age moderated ease of use.
5	Factors Affecting Consumers' Adoption of Virtual Banks in Thailand (Kaewnin, 2024)	Thailand	Quantitative (Survey, SEM, n=600)	TAM with Extended External Variables	Corporate Reputation, Safety, Innovativeness, Cost, Usefulness, Ease of Use	All hypotheses supported; corporate reputation and perceived safety indirectly increased behavioral intention via usefulness and ease of use; validated the extended TAM for Thai consumers.
6	Banking without borders: What drives neobank use in Peru (Minchan-Wolstrohn & Rodríguez-Serra, 2025)	Peru	Mixed Methods (Survey + Interviews)	UTAUT2 + Trust	Effort Expectancy, Performance Expectancy, Hedonic Motivation, Trust	Digital trust and perceived convenience were strongest predictors of continued use; hedonic motivation had an indirect effect via satisfaction.
7	Building Attitude, Trust, and Social Capital in Virtual Banking (Soelasih et al., 2025)	Indonesia	Quantitative (SEM–PLS, n=273)	TAM + UTAUT + Trust	Attitude, Trust, Social Influence, Gender Moderation	Attitude, trust, and social influence positively affected behavioral intention; perceived security increased trust; gender moderated the trust–intention path (stronger for females).
8	The Role of Neobanks and FinTech in Sustainable Finance and Technology (Palos-Sánchez et al., 2025)	Global (Europe & Latin America)	Text-Mining & Sentiment Analysis (n=56,474 app reviews)	FinTech Innovation Framework / Sentiment Analysis	Customer Experience, Usability, Trust, Security, Sustainability	Positive sentiments dominated among young users; older users cited usability and cybersecurity barriers. Revealed key adoption themes: design, transparency, and trust.

3.1.2. Thematic findings

The synthesis of the eight reviewed studies revealed four major behavioral themes that shape virtual banking adoption: trust, perceived risk, digital readiness, and consumer innovativeness. These themes reflect interrelated psychological and contextual mechanisms influencing user behavior across both developed and emerging markets. As summarized in Table 3, the reviewed literature consistently highlights these constructs as central determinants of adoption outcomes. The table is followed by a thematic interpretation that elaborates on how each factor operates within different institutional and cultural settings.

Across the reviewed studies, virtual banking is consistently characterized as a digital-only financial model that reshapes how consumers perceive accessibility, efficiency, and institutional reliability. Unlike conventional banks that depend on physical branches, virtual banks provide services entirely through digital platforms using mobile applications, cloud infrastructure, and artificial intelligence to personalize user experiences (Schatt, 2014; Vives, 2019). This model improves cost efficiency and accessibility but also raises new concerns about regulation, data privacy, and systemic stability. Globally, digital-only institutions such as Monzo, Revolut, and WeBank have changed how customers perceive banking convenience and transparency (Nam & Yi, 2020; Rybacki, 2022; Sammour & Chen, 2019).

Evidence from Asian contexts further indicates that adoption is shaped not only by technological readiness but also by regulatory credibility and behavioral confidence. In Asia, the development of virtual banking reflects both rapid progress and persistent inequality. Economies such as Hong Kong, Singapore, and South Korea have implemented licensing frameworks to promote competition and financial inclusion (Creutz, 2023; Vijayaraghavan, 2023). In contrast, emerging economies such as Thailand, Vietnam, and Indonesia remain in early stages of regulatory adaptation and consumer readiness. The coexistence of digital optimism and institutional skepticism makes the Asian context distinctive. Technological readiness alone does not guarantee adoption; users' behavioral confidence, cultural norms, and trust in regulation remain decisive factors (Akbari et al., 2025; Tuli, 2024).

The synthesis also shows that the absence of face-to-face interaction fundamentally alters how users evaluate safety and control in virtual banking environments. Critically, virtual banking differs in nature from earlier innovations such as mobile or internet banking. The absence of face-to-face interaction fundamentally changes how users perceive safety and control. Consumers must evaluate system reliability through digital cues such as interface design, branding, and perceived institutional legitimacy (Lee & Chen, 2022). Understanding adoption therefore requires not only technological variables but also behavioral and contextual mechanisms that influence how individuals build trust in intangible systems.

Trust consistently appeared as the most influential behavioral construct across seven of the eight studies. In Brazil, Mangini et al. (2020) demonstrated that trust mediated the effects of performance and effort expectancy on behavioral intention, reinforcing the Technology Acceptance Model. Similarly, in Malaysia, Saif et al. (2022) found that perceived usefulness and trust jointly predicted positive attitudes toward digital-only banks. In Thailand, Kaewnin (2024) reported that institutional trust, shaped by corporate reputation and perceived technological safety, had a stronger effect on behavioral intention than ease of use. Complementary evidence from Indonesia confirmed that trust operated as a psychological bridge between security perceptions and adoption intention (Soelasih et al., 2025). At the global level, Palos-Sánchez et al. (2025) identified trust differentials across age groups, showing that older users expressed greater concern over cybersecurity than younger, digitally fluent users. Collectively, these studies underscore that trust in virtual banking operates simultaneously at technological, institutional, and relational levels, serving as the foundation for user confidence and long-term engagement.

This multidimensional role of trust aligns with the distinction between institutional trust and technological trust, where adoption depends not only on system reliability but also on regulatory legitimacy and organizational reputation (Zhu et al., 2009). Accordingly, prior research suggests that trust strengthens users' willingness to rely on digital financial systems and supports intention formation, particularly when institutional credibility is salient (Alalwan et al., 2018b; Kaabachi et al., 2017).

Perceived risk emerged as a consistent negative predictor of adoption across different regions. In Brazil, Mangini et al. (2020) found that perceived risk offset the positive effects of usefulness and ease of use, reducing behavioral intention to use virtual banks. A Hungarian study by Nagy et al. (2024) similarly confirmed that higher levels of financial and data-security risk significantly weakened user trust and perceived usefulness. A large-scale sentiment analysis conducted by Palos-Sánchez et al. (2025) further revealed that cybersecurity anxiety and privacy concerns were the dominant sources of negative sentiment among older and less tech-savvy users. While developed markets benefited from clear regulatory frameworks that reduced uncertainty, emerging Asian economies continued to face skepticism due to limited legal protection and lower digital trust. Overall, these findings indicate that risk perceptions are not purely technological but also institutional, reflecting user confidence in financial governance and consumer protection systems. This pattern supports the view that the trust-risk relationship is contingent and context-dependent: in some settings trust dampens the effect of perceived risk, while in others it may be insufficient to offset privacy anxiety or fear of institutional failure (Kehr et al., 2015). Such variation suggests that consumers' vulnerability assessments are shaped by cultural norms and the perceived credibility of regulation, which is particularly relevant in emerging Asian economies (Kraiwanit et al., 2024; Vafaei-Zadeh et al., 2025).

Table 3 Summary of thematic findings.

Theme	Supporting Studies	Direction of Effect	Key Insight
Trust	Kaewnin (2024); Mangini et al. (2020); Minchan-Wolstrohn and Rodríguez-Serra (2025); Nagy et al. (2024); Palos-Sánchez et al. (2025); Soelasih et al. (2025)	Positive	Trust is a pivotal determinant of adoption; it mediates the influence of perceived security and usefulness on behavioral intention. Institutional and brand trust are especially crucial in markets with low fintech maturity.
Perceived Risk	Mangini et al. (2020); Nagy et al. (2024); Palos-Sánchez et al. (2025)	Negative	High perceived risk—particularly regarding data security and privacy—deters user adoption. Effective communication and risk mitigation strategies enhance acceptance.
Perceived Usefulness / Performance Expectancy	Kaewnin (2024); Mangini et al. (2020); Nagy et al. (2024); Saif et al. (2022); Soelasih et al. (2025);	Positive	Usefulness remains a consistent and direct driver of attitude and behavioral intention; users adopt neobanks when they perceive tangible efficiency and convenience benefits.
Ease of Use / Effort Expectancy	Kaewnin (2024); Mangini et al. (2020); Nagy et al. (2024); Saif et al. (2022); Soelasih et al. (2025);	Positive	Simplicity and user-friendly interfaces reduce cognitive barriers and strengthen adoption intention, particularly among new digital users.
Security and Privacy	Kaewnin (2024); Palos-Sánchez et al. (2025); Soelasih et al. (2025)	Positive	Perceived security significantly builds trust and perceived usefulness; older consumers emphasize cybersecurity as a precondition for adoption.
Social Influence	Minchan-Wolstrohn & Rodríguez-Serra (2025); Nagy et al. (2024); Soelasih et al. (2025)	Positive	Peer and societal influence, especially through digital communities and word-of-mouth, reinforces adoption intentions and moderates attitude formation.
Innovativeness	Kaewnin (2024); Monaghan et al. (2020); Palos-Sánchez et al. (2025)	Positive	Consumer and organizational innovativeness foster openness to neobanking, yet adoption still hinges on safety perception and institutional legitimacy.
Demographic Moderators (Gender, Age, Literacy)	Nagy et al. (2024); Palos-Sánchez et al. (2025); Soelasih et al. (2025)	Mixed	Gender moderates trust–intention links (stronger among females), while younger and digitally literate users show higher adoption and satisfaction levels.

Although not all studies addressed digital literacy explicitly, evidence from multiple contexts suggests that users' technological competence strongly influences their perceptions of ease of use and trust. In Hungary, Nagy et al. (2024) observed that younger users with higher digital familiarity reported significantly higher confidence and lower perceived risk. Similarly, Kaewnin (2024) showed that Thai users who rated themselves as digitally capable were more likely to perceive virtual banking as secure, efficient, and convenient. Sentiment analysis in Palos-Sánchez et al. (2025) also indicated that satisfaction and positive attitudes were concentrated among digitally fluent users. Conversely, lower literacy and limited exposure to online financial systems remained key barriers to adoption among older consumers. Collectively, the literature demonstrates that digital readiness functions as both an enabler and a moderator: it strengthens self-efficacy and trust while reducing uncertainty and perceived complexity. This evidence-based pattern aligns with the broader concept of digital literacy, which refers to individuals' ability to locate, evaluate, and effectively use digital tools in complex service environments (Gilster, 1997; Reddy et al., 2020; Tinmaz et al., 2022). Within financial contexts, digital literacy encompasses managing online accounts, recognizing security cues, and understanding digital transactions (Koskelainen et al., 2023; Zaimovic et al., 2024). Across emerging economies, disparities in digital literacy—particularly across age, education, and income groups—shape users' confidence and perceived control, thereby influencing adoption outcomes (Nguyen & Vo, 2025).

Consumer innovativeness was consistently identified as a positive determinant of virtual banking adoption. In their conceptual analysis of born-digital firms, Monaghan et al. (2020) argued that technological affordances and scalability facilitate early international expansion and user engagement, highlighting innovation as a structural enabler of digital transformation. Empirical findings from Kaewnin (2024) showed that personal innovativeness among Thai consumers directly enhanced perceived usefulness and ease of use, thereby increasing adoption intention. Likewise, Palos-Sánchez et al. (2025) demonstrated that global consumers with innovative tendencies expressed stronger enthusiasm toward neobank services, particularly in app-based ecosystems emphasizing usability and personalization. However, the strength of this relationship varied across cultural contexts. In collectivist Asian societies, innovative users still relied on institutional legitimacy and peer validation before adoption, whereas consumers in mature fintech environments exhibited higher autonomy between innovativeness and trust. These insights suggest that innovativeness drives early adoption but remains dependent on the

coexistence of trust and perceived safety for sustained usage. This pattern is consistent with the concept of consumer innovativeness, defined as an individual's propensity to adopt new ideas and technologies earlier than others (Manning et al., 1995; Midgley & Dowling, 1993). In virtual banking contexts, innovativeness captures users' curiosity and openness toward digital change, which enhances willingness to experiment with novel financial platforms when perceived usefulness is high and perceived risk is manageable (Alalwan et al., 2018b; Yang et al., 2022).

3.1.3. Synthesis of findings

The synthesis of results highlights an integrated behavioral mechanism in which trust and perceived risk form the central axis of virtual banking adoption, while digital readiness and innovativeness operate as enabling and moderating factors. Trust enhances perceived usefulness and reduces uncertainty, whereas perceived risk exerts the opposite effect by undermining confidence in digital transactions. Users with high digital literacy experience fewer barriers and higher perceived control, while innovative consumers display stronger curiosity and exploratory behavior that facilitate early engagement. Nevertheless, in emerging economies such as Thailand, Malaysia, and Indonesia, the decision to adopt remains influenced more by institutional credibility and perceived security than by technological performance alone. Together, these findings affirm that virtual banking adoption is best understood through an integrated behavioral framework that combines the Technology Acceptance Model with cultural, institutional, and cognitive perspectives (Kaewnin, 2024; Mangini et al., 2020; Nagy et al., 2024; Palos-Sánchez et al., 2025; Saif et al., 2022; Soelasih et al., 2025).

3.2. Discussion

This review examined the behavioral foundations of virtual banking adoption and explored how trust, perceived risk, digital readiness, and innovativeness have been theorized and linked to technology acceptance in emerging economies. The findings are interpreted through behavioral and design-thinking perspectives to explain why these factors matter and how they interact within Asia's digital finance landscape.

3.2.1. Behavioral factors shaping virtual banking adoption

Across the reviewed studies, four behavioral dimensions consistently shaped consumer adoption. Trust was the most influential psychological condition for intention, while perceived risk was the main deterrent (Kaewnin, 2024; Mangini et al., 2020; Nagy et al., 2024; Saif et al., 2022). Digital readiness and innovativeness enhanced adoption by increasing confidence and openness to new technology (Monaghan et al., 2020; Palos-Sánchez et al., 2025). In emerging economies, users' decisions relied more on institutional credibility, regulatory transparency, and social reputation than on usability alone (Kaewnin, 2024; Soelasih et al., 2025). High perceived risk, particularly related to privacy and fraud, discouraged usage even when usefulness was evident. Digital readiness reduced uncertainty by strengthening perceived control, while innovativeness encouraged exploration once safety and trust were established. Adoption in virtual banking therefore reflects a negotiation between confidence and uncertainty rather than a purely rational choice.

Importantly, innovativeness should not be interpreted as a purely individual disposition. In collectivist Asian contexts, technology adoption is frequently shaped by social norms, peer validation, and perceived institutional endorsement, which may constrain the influence of personal innovativeness in the absence of trust and regulatory legitimacy (Didenko et al., 2020). This suggests that even highly innovative users may delay adoption when perceived vulnerability remains high or when institutional assurance is insufficient.

Importantly, the reviewed evidence suggests that trust and risk are not universal in meaning or weight across societies. In higher-trust environments, users may prioritize efficiency and usability, whereas in lower-trust contexts institutional credibility and perceived regulatory protection become more decisive in shaping adoption judgments. Consistent with prior trust-risk research, trust may function as a mechanism that mitigates perceived risk in some settings, while in others it may be insufficient to offset anxiety related to privacy or institutional failure (Kehr et al., 2015). This reinforces the need to interpret trust-risk dynamics through contextual and institutional lenses when explaining adoption in emerging economies.

Crucially, the findings reveal a distinctive adoption dynamic in Emerging Economies compared to developed markets (e.g., Europe). While studies from Hungary and Western contexts emphasize technological and system trust, Asian consumers place a significantly higher weight on institutional credibility and government regulation when assessing risk. This regional distinction validates the focus of the Behavioral Confidence Framework, confirming that confidence relies more heavily on external, social, and regulatory assurance in these emerging contexts.

3.2.2. Conceptualization and measurement of behavioral constructs

The studies conceptualized trust primarily as confidence in system reliability but also as belief in institutional integrity and social assurance in Asian settings (Kaewnin, 2024; Soelasih et al., 2025). Perceived risk was defined as fear of data or financial loss, yet few studies distinguished among its subdimensions (Mangini et al., 2020; Nagy et al., 2024). Digital readiness was commonly measured through self-reported competence, which may overestimate ability (Kaewnin, 2024). Innovativeness

appeared as both an individual trait and a culturally moderated orientation influenced by social legitimacy (Monaghan et al., 2020; Palos-Sánchez et al., 2025). Greater conceptual precision is needed to distinguish cognitive, affective, and contextual components of these constructs.

The synthesis of the reviewed studies reveals notable inconsistencies in how behavioral determinants of virtual banking adoption are explained across contexts. However, empirical findings remain inconsistent. Some studies emphasize perceived risk as the dominant inhibitor, whereas others identify trust as the mediating factor that mitigates risk (Cenfetelli, 2004; Sjöberg, 2008). A critical implication of the reviewed evidence is that digital literacy should not be treated merely as a background condition. Rather, literacy operates as a behavioral determinant that both enables adoption by increasing perceived control and moderates trust–risk evaluations, particularly in environments where institutional credibility is uncertain. In such contexts, higher literacy may simultaneously reduce operational anxiety while heightening awareness of systemic risk. Consumer innovativeness was consistently identified as a complementary behavioral driver that reinforces adoption intention once adequate digital literacy, consumer protection, and institutional trust-building mechanisms are in place. This finding suggests that innovativeness alone is insufficient to sustain virtual banking adoption unless it is supported by literacy development and credible regulatory assurance. These contradictions reveal that contextual differences, especially cultural values and regulatory credibility, strongly influence how behavioral constructs operate. Moreover, traditional models often neglect structural constraints such as literacy gaps and socioeconomic inequality that affect adoption in emerging markets. This indicates the need for a broader behavioral framework that incorporates both individual and contextual determinants.

3.2.3. *Dominant theoretical and methodological approaches*

Most research employed cross-sectional surveys using the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (Mangini et al., 2020; Nagy et al., 2024; Saif et al., 2022). Within the reviewed studies, these theories were primarily used as analytical lenses rather than explanatory frameworks, revealing limitations when applied to virtual banking contexts. Such models capture cognitive drivers of intention but overlook institutional and cultural factors. More recent models incorporating corporate reputation, perceived safety, and social capital have begun to address these gaps (Kaewnin, 2024; Soelasih et al., 2025). The Diffusion of Innovation theory provides an additional lens for early adoption and openness to change (Monaghan et al., 2020). However, the field remains dominated by structural equation modeling, with limited qualitative or longitudinal designs. Broader methodological diversity, including text mining and sentiment analysis, would reveal behavioral changes over time and across regulatory contexts (Palos-Sánchez et al., 2025).

3.2.4. *Toward an integrated behavioral framework*

The synthesis suggests that virtual banking adoption is a process of confidence formation. Three mechanisms, synthesized from the core behavioral constructs reviewed, describe this process. Confidence reflects the psychological state in which trust outweighs perceived risk, providing emotional security and capturing the willingness of users to engage with these intangible financial systems given institutional legitimacy. Competence represents digital capability and perceived control. This mechanism is primarily derived from Digital Literacy, ensuring users possess the self-efficacy and skills necessary to navigate the virtual banking interface and manage complexity, thereby ensuring readiness. Lastly, Curiosity denotes the motivation to explore and sustain engagement. This mechanism is closely linked to Consumer Innovativeness, which drives early adoption behavior and continued interaction once perceived safety is established, thus maintaining commitment. Adoption ultimately occurs when these mechanisms align within a trustworthy institutional and cultural environment.

This integrative perspective is consistent with prior research emphasizing the interdependence of trust, perceived risk, and user capability in shaping fintech and digital service adoption, particularly in environments characterized by uncertainty and institutional transition (Alhassan et al., 2022; Parasuraman & Colby, 2015). Moreover, by unifying these constructs into a single confidence-building process, the proposed framework responds to longstanding calls for more context-sensitive and integrative models that move beyond isolated predictors and Western-centric technology acceptance assumptions (Kaur et al., 2021; Liao et al., 1999).

This interaction reframes technology acceptance from ease of use to ease of confidence, emphasizing that successful adoption depends on trust, safety, and self-efficacy as much as on technical performance.

3.2.5. *Theoretical implications*

This synthesis proposes a Behavioral Confidence Framework that integrates trust, digital literacy, and innovativeness under conditions of perceived uncertainty. The framework extends the Technology Acceptance Model and the Unified Theory of Acceptance and Use of Technology by embedding social, psychological, and cultural dimensions that are central to financial technology adoption in emerging markets (Kaewnin, 2024; Mangini et al., 2020; Soelasih et al., 2025). It conceptualizes adoption as a dynamic process through which users develop confidence through institutional reliability and digital competence. As illustrated in Figure 2, the framework comprises three interrelated mechanisms: confidence, competence, and curiosity.

Future research is encouraged to empirically test this framework using longitudinal and mixed-method approaches. The three mechanisms can be operationalized using established measures of institution-based trust and perceived risk, digital literacy and perceived control, and consumer innovativeness and motivational orientation, respectively. Incorporating trust-by-design and literacy-by-design strategies would further enable researchers to examine how confidence, competence, and curiosity interact to foster sustainable and inclusive virtual banking ecosystems in Asia.

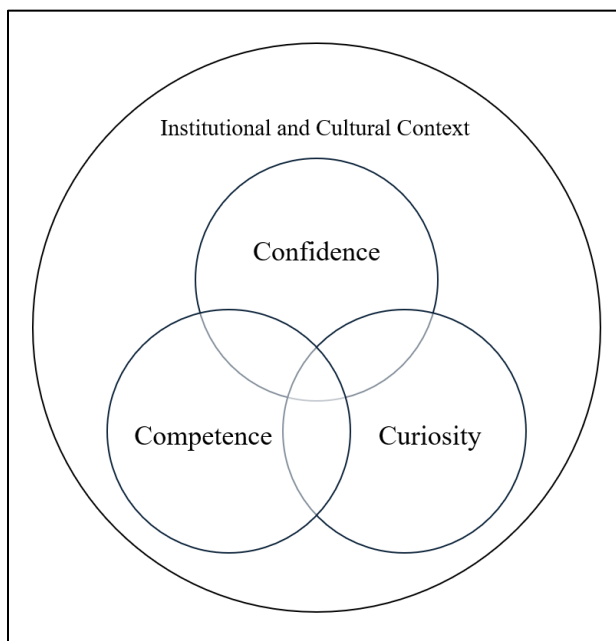


Figure 2 Integrated behavioral framework for virtual banking adoption.

3.2.6. Practical implications for fintech and policy

The findings carry clear implications for fintech design, regulation, and inclusion. Designing for confidence should be a guiding principle in digital finance: interfaces must make security and privacy visible through transparent confirmations, clear transaction histories, and concise data explanations (Featherman & Pavlou, 2003). Localized content and culturally responsive design can narrow psychological distance and strengthen user comfort. For regulators, transparent governance and inter-agency coordination across central banks and financial authorities are vital to align cybersecurity and consumer-protection standards (Kaewnin, 2024). Public communication of audits and safety measures can transform regulation into a visible signal of reliability. At the societal level, digital-literacy partnerships among governments, universities, and the private sector are needed to reduce inequality and foster confidence. Adopting literacy-by-design, where platforms teach as they serve, will extend inclusion to underserved populations.

3.2.7. Limitations and future research directions

This review was constrained by the limited scope and methodological homogeneity of the available studies. Most research concentrated on East and Southeast Asian economies and relied heavily on cross-sectional survey data, which may not fully capture the evolving dynamics of behavioral confidence in virtual banking. Broader comparative studies across regions and longitudinal analyses would provide a more comprehensive understanding of how trust, digital readiness, and innovativeness develop as users gain sustained experience with digital finance.

Future investigations should empirically test the proposed Behavioral Confidence Framework through multi-method and design-based approaches. Mixed-method and experimental research could explore how trust-by-design and literacy-by-design interventions influence adoption, satisfaction, and long-term engagement. Expanding both theoretical and methodological boundaries will deepen understanding of how confidence, competence, and curiosity interact to foster sustainable virtual banking ecosystems in Asia.

4. Conclusion

This review synthesizes the behavioral foundations of virtual banking adoption by integrating trust, perceived risk, digital literacy, and innovativeness into a unified Behavioral Confidence Framework. The findings demonstrate that adoption is driven not only by technological functionality but by the convergence of three behavioral mechanisms: confidence, which arises when trust outweighs perceived risk; competence, which reflects the self-efficacy and digital capability required to navigate complex



financial technologies; and curiosity, which represents the intrinsic motivation to explore and sustain engagement with new digital systems.

The framework advances existing models of technology acceptance by embedding psychological, cultural, and institutional dimensions that are particularly relevant to emerging economies. It emphasizes that the success of fintech innovations depends on human confidence as much as on technological sophistication. Building trustworthy and inclusive ecosystems therefore requires deliberate attention to design, governance, and education—systems must be created to inspire trust, strengthen digital literacy, and encourage responsible innovation.

Ultimately, the evolution of virtual banking in Asia rests on the collective capacity of businesses, regulators, and consumers to create financial environments that people trust, comprehend, and are eager to participate in. When confidence becomes a shared societal asset, digital finance transforms from a technological advancement into a force for empowerment, inclusion, and sustainable growth. Investing in this behavioral confidence will determine Asia's potential to lead the next era of global financial transformation.

5. Declarations

5.1. Ethical considerations

Not applicable.

5.2. Use of artificial intelligence (AI)

The authors declare that the generative artificial intelligence (AI) tool ChatGPT was used exclusively for language editing and grammatical improvement. The use of AI did not influence the scientific content, study design, data analysis, data interpretation, results, or conclusions of the manuscript. Full responsibility for the content remains with the authors.

5.3. Conflict of interest

The authors declare no conflicts of interest.

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