Explaining blockchain adoption through a mechanism-based TOE–TAM integration: evidence from financial institutions

Journal of Enterprise Information Management

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Received 20 April 2026
Revised 15 June 2026
16 July 2026
Accepted 19 July 2026

Abstract

Purpose – This study explains blockchain adoption in financial institutions through a mechanism-based integration of the technology–organization–environment (TOE) framework and the technology acceptance model (TAM). It examines how technological, organizational and environmental conditions are translated into blockchain adoption through cognitive evaluations of perceived ease of use and perceived usefulness.

Design/methodology/approach – A quantitative design was employed using survey data from 479 employees in financial institutions. The proposed model was tested through structural equation modeling (SEM), enabling the examination of direct, indirect and sequential mediation effects among TOE dimensions, perceived ease of use, perceived usefulness and blockchain adoption.

Findings – Blockchain adoption is explained primarily by perceived usefulness, while perceived ease of use influences adoption directly and indirectly through usefulness. Contextual factors do not act as uniform predictors but are filtered through usability and value-based paths before adoption occurs. Technological and organizational factors operate through differentiated perceptual pathways: perceived financial benefits and information security strongly enhance usefulness, whereas complexity mainly reduces ease of use. Among environmental factors, partner readiness exerts a stronger effect on adoption than competitive pressure. The results also support a sequential perceived ease-of-use–perceived-usefulness–adoption mechanism across TOE dimensions.

Originality/value – The study moves beyond additive TOE–TAM integration by establishing a theoretical chain that explains blockchain adoption as a multistage process. It contributes by providing evidence of a sequential ease-of-use–usefulness–adoption mechanism and by showing that, in financial institutions, TAM operates hierarchically rather than symmetrically, with usefulness emerging as the primary adoption mechanism.

Keywords Blockchain adoption, Financial institutions, Technology–organization–environment (TOE) framework, Technology acceptance model (TAM), Structural equation modeling

Paper type Research article

1. Introduction

Every second, millions of digital transactions flow through the global financial system, yet establishing trust in these exchanges remains one of the most critical and costly challenges

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Funding: This work was supported by the Scientific Research Projects Coordination Unit of Selcuk University (Project No. 26601083).

Conflict of interest: The authors declare no competing interests.

Journal of Enterprise Information Management
Emerald Publishing Limited
e-ISSN: 1758-7409
p-ISSN: 1741-0398
DOI 10.1108/JEIM-04-2026-0660

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organizations face. Financial institutions devote substantial resources to verification, reconciliation and fraud prevention precisely because existing infrastructures cannot guarantee transaction integrity on their own. Blockchain technology has emerged as a promising response to this trust problem. Its decentralized architecture, immutable data structure and cryptographic security mechanisms are commonly associated with greater transparency, stronger trust and improved process efficiency. In financial institutions, where transaction integrity, security and auditability are central, blockchain is frequently presented as a technology with the potential to transform established operational models (Letho *et al.*, 2022; Zheng *et al.*, 2025). Prior studies emphasize its ability to improve traceability, reduce transaction costs and support secure information sharing across organizational boundaries (Osmani *et al.*, 2021; Happy *et al.*, 2023; Chen *et al.*, 2025). Research in financial-service settings also suggests that blockchain can reduce settlement delays, lower transaction frictions and support alternative value-transfer models in cross-border exchanges (Christodoulou *et al.*, 2024).

Despite these advantages, large-scale blockchain adoption in financial institutions remains limited (Jena, 2022). A persistent gap exists between the technology's theoretical promise and its actual implementation (Bag *et al.*, 2023; Chittipaka *et al.*, 2023; Malik *et al.*, 2020, 2021). This gap suggests that technological potential alone is insufficient to explain adoption. Instead, adoption depends on the interaction of technological characteristics, organizational readiness, environmental pressures and user perceptions (Lu *et al.*, 2024). This issue is especially important in financial institutions, where adoption decisions are shaped not only by efficiency considerations but also by regulatory constraints, risk management requirements, stakeholder dependence and trust-sensitive operations (Deng *et al.*, 2022; Hashimy *et al.*, 2023). The same tension is visible in studies showing that blockchain may improve transparency and accountability, yet remain difficult, costly and time-consuming to implement in practice (Sung and Park, 2021).

Existing research remains fragmented in explaining this complexity. One major stream relies on the technology–organization–environment (TOE) framework and emphasizes structural conditions such as compatibility, organizational capability and environmental pressure (Behl *et al.*, 2024; Pandey and Pathak, 2025). While valuable, this perspective often assumes that such contextual factors translate directly into adoption outcomes, thereby underexplaining the cognitive processes through which they are interpreted within organizations. A second stream relies on the technology acceptance model (TAM) and focuses on perceived usefulness and perceived ease of use as determinants of adoption behavior (Jain *et al.*, 2020; Purusottama *et al.*, 2025). Although this perspective clarifies user cognition, it often abstracts away from the organizational and environmental context in which those perceptions are formed.

As a result, prior research is theoretically incomplete in two ways. TOE-based studies often oversimplify adoption by treating contextual factors as direct predictors (Behl *et al.*, 2024; Pandey and Pathak, 2025), whereas TAM-based studies decontextualize adoption by isolating user perceptions from their institutional setting (Jain *et al.*, 2020; Purusottama *et al.*, 2025). In highly regulated and trust-intensive environments such as financial institutions, this separation is especially problematic. Blockchain adoption cannot be adequately explained as either a direct consequence of structural readiness or a purely individual-level attitudinal response.

This study addresses that limitation by developing a mechanism-based integration of two established theoretical frameworks. The TOE framework, originally proposed by Tornatzky and Fleischer (1990), explains technology adoption through three contextual dimensions: the characteristics of the technology itself, the organizational conditions in which it will be deployed and the external environment surrounding the firm. The TAM, introduced by Davis (1989), explains individual-level adoption through perceived usefulness, defined as the degree to which a technology is believed to enhance performance, and perceived ease of use, defined as the degree to which it is expected to be free of effort. While both frameworks are well

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established individually, their integration in blockchain research has largely been additive rather than mechanism-based.

Financial institutions provide an especially important context for this investigation. In contrast to general organizational settings, banks and similar entities operate under strict regulatory oversight, are accountable to multiple stakeholder groups and face heightened sensitivity to operational risk and reputational exposure. These characteristics mean that adoption decisions are rarely driven by individual-level enthusiasm alone but are instead embedded in institutional processes of evaluation, legitimation and risk assessment. Blockchain's potential to reduce settlement delays, strengthen auditability and lower transaction costs is well recognized, yet the gap between pilot interest and full-scale implementation remains wide (Lu *et al.*, 2024). Understanding why requires explaining not only what contextual conditions are present, but how those conditions are translated into institutional support through individual-level cognitive evaluations. These institutional characteristics also generate a specific theoretical expectation examined in this study. In performance-accountable and risk-sensitive environments, adoption decisions must ultimately be justified in terms of demonstrable value. Consequently, perceived usefulness is expected to dominate the adoption decision. Perceived ease of use, by contrast, is expected to function primarily as a precursor that shapes value judgments rather than as an independent, co-equal determinant. This asymmetric expectation guides the hypothesis development and is examined empirically in the analysis.

The study contributes to the literature by repositioning TOE contextual factors as antecedents of TAM perceptions rather than as parallel predictors of adoption. In doing so, it explains blockchain adoption as a contextual-to-cognitive translation process in which technological, organizational and environmental conditions shape perceived ease of use and perceived usefulness before adoption behavior develops. The study further shows that TAM operates hierarchically in financial institutions, with perceived usefulness emerging as the primary adoption mechanism and perceived ease of use functioning mainly as a precursor to usefulness. It also identifies asymmetric mediation patterns across TOE dimensions, showing that complexity operates mainly through usability perceptions, whereas financial benefits and information security operate through value-based pathways. Finally, by supporting a sequential perceived ease-of-use–perceived-usefulness–adoption mechanism across TOE dimensions, the study provides a more fine-grained account of how contextual conditions are translated into blockchain adoption behavior.

2. Literature review and hypotheses development

2.1 Theoretical background: the TOE framework and TAM

The TOE framework, proposed by Tornatzky and Fleischer (1990), provides a multi-level explanation of technology adoption by identifying three contextual categories that jointly shape organizational decisions. The technological dimension captures the attributes of the technology under consideration, including its relative advantage over existing alternatives, its compatibility with existing systems and practices and the complexity that may inhibit its implementation. The organizational dimension encompasses the internal characteristics of the firm, such as its available resources, managerial commitment and human capital readiness. The environmental dimension addresses the external context in which the firm operates, including competitive dynamics and the readiness of business partners and ecosystem actors. Together, these dimensions offer a comprehensive structural account of why some organizations adopt new technologies while others delay or resist. The framework has been applied extensively to enterprise systems, cloud computing and, more recently, blockchain and emerging digital infrastructures (Gangwar *et al.*, 2015; Behl *et al.*, 2024; Benchis *et al.*, 2025; Pandey and Pathak, 2025). Applications to metaverse adoption have further validated its utility for explaining technology uptake in complex innovation contexts characterized by high

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uncertainty and ecosystem dependencies (Al-Adwan and Abdeljaber, 2025; Al-Adwan *et al.*, 2026).

TAM, developed by Davis (1989), explains individual-level technology adoption through two core cognitive constructs. Perceived usefulness (PU) refers to the degree to which a person believes that using a technology will improve their job performance, while perceived ease of use (PEU) refers to the degree to which using the technology is expected to be free of effort. TAM posits that PEU influences PU directly, and that both constructs shape behavioral intention to use the technology. Decades of empirical research confirm the robustness of these relationships across a wide range of technologies and user populations (Davis, 1989; Wider *et al.*, 2025). However, TAM has been criticized for abstracting away from the organizational and contextual conditions that give rise to these perceptions. In institutional settings such as financial services, where adoption decisions are embedded in regulatory constraints, managerial authority and interorganizational dependencies, context-free perceptual models provide only a partial account of adoption behavior.

The integration of TOE and TAM addresses this limitation by linking contextual antecedents to individual perceptions and, through them, to adoption behavior. Prior integrations of the two frameworks have treated TOE dimensions and TAM constructs as parallel predictors or have used TOE factors as direct controls alongside TAM constructs (Gangwar *et al.*, 2015; Awa and Ojiabo, 2016). The present study moves beyond this additive logic by proposing a mechanism-based integration in which most TOE dimensions influence adoption primarily through their effects on PEU and PU, while environmental factors may also retain direct effects because of the interorganizational nature of blockchain adoption (Tornatzky and Fleischer, 1990). It implies that the same structural conditions such as organizational capability or competitive pressure may produce different adoption outcomes depending on how they shape the cognitive evaluations of the individuals responsible for implementation decisions.

2.2 Technological antecedents of blockchain adoption

The technological dimension of blockchain adoption is commonly discussed through relative advantage, compatibility, complexity, technical knowledge, financial benefits and information security. Prior research shows that blockchain's ability to improve transparency, strengthen data integrity and reduce transaction costs contributes to its perceived value within organizations (Bag *et al.*, 2023; Wang *et al.*, 2022). Relative advantage and compatibility are therefore often treated as central drivers of adoption (Wong *et al.*, 2020a). Yet this treatment is often too direct, because technological attributes do not automatically generate adoption but must first be interpreted by users. This issue is especially visible in the case of complexity, which is widely identified as a major barrier, yet rarely examined in terms of whether it reduces PU, PEU or both (Wong *et al.*, 2020b; Malik *et al.*, 2020, 2021; Chittipaka *et al.*, 2023). A similar logic applies to technical knowledge, financial benefits and information security, which appear to shape adoption by influencing user evaluations rather than through uniform direct effects (Kumar Singh *et al.*, 2024). In financial institutions, where operational efficiency, system fit and risk management are decisive, relative advantage and compatibility should strengthen both usefulness and ease-of-use perceptions, whereas complexity should exert a stronger negative effect on PEU than on PU. Technical knowledge, perceived financial benefits and information security should likewise strengthen positive evaluations by reducing uncertainty and increasing value recognition (Deng *et al.*, 2022; Hashimy *et al.*, 2023; Kamble *et al.*, 2019).

Six constructs characterize the technological context. Relative advantage refers to the degree to which blockchain is perceived as superior to existing alternatives in terms of efficiency, accuracy and operational performance (Rogers, 2003). Compatibility denotes the extent to which blockchain is consistent with users' existing values, prior experiences and current systems. Complexity is defined as the degree to which blockchain is perceived as

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difficult to understand and use. Technical knowledge refers to the breadth of expertise that users must possess to evaluate and implement blockchain technology effectively (Kumar Singh *et al.*, 2024). Perceived financial benefits denote the anticipated economic returns including cost savings, revenue generation and improved operational efficiency expected from blockchain adoption (Deng *et al.*, 2022). Information security is defined as the degree to which blockchain is perceived to protect data from unauthorized access and to maintain the integrity and confidentiality of transactions (Hashimy *et al.*, 2023).

H1a. Relative advantage positively affects PU.

H1b. Relative advantage positively affects PEU.

H2a. Compatibility positively affects PU.

H2b. Compatibility positively affects PEU.

H3a. Complexity negatively affects PU.

H3b. Complexity negatively affects PEU.

H4a. Technical knowledge positively affects PU.

H4b. Technical knowledge positively affects PEU.

H5a. Perceived financial benefits positively affect PU.

H5b. Perceived financial benefits positively affect PEU.

H6a. Information security positively affects PU.

H6b. Information security positively affects PEU.

2.3 Organizational conditions and perceptual influence

Three constructs characterize the organizational context. Organizational capability refers to the availability of internal resources, technical infrastructure and human capital that an organization can mobilize for blockchain implementation (Gangwar *et al.*, 2015). Top management support is defined as the degree to which senior executives actively champion, resource and legitimize blockchain adoption initiatives (Behl *et al.*, 2024). Training and education denote the extent to which the organization provides formal and informal learning opportunities to equip employees with the knowledge and competencies needed to use blockchain technology effectively (Khalil *et al.*, 2022).

Organizational factors such as organizational capability, top management support and training are consistently identified as important enablers of blockchain adoption (Behl *et al.*, 2024; Malik *et al.*, 2020, 2021). The literature typically frames these variables as structural conditions that facilitate implementation by providing resources, legitimacy and strategic direction. However, this perspective remains incomplete if it overlooks their influence on individual perception. Organizational capability signals whether blockchain implementation appears feasible, while top management support not only allocates resources but also reduces uncertainty and legitimizes adoption. Likewise, training and education do more than transfer technical knowledge; they can make blockchain appear more understandable and practically relevant. Existing studies therefore suggest that these organizational factors shape user confidence and interpretation, not merely structural readiness (Khwaji, 2022; Khalil *et al.*, 2022). Organizational conditions should thus be understood as having a dual role: they create firm-level readiness while also shaping ease-of-use and usefulness perceptions. On this basis, organizational capability is expected to enhance both PU and PEU by reducing operational uncertainty and enabling effective implementation. Top management support and training should likewise strengthen these perceptual evaluations through legitimacy signaling, resource

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provision and competence development (Gangwar *et al.*, 2015; Awa and Ojiabo, 2016; Kamble *et al.*, 2021).

H7a. Organizational capability positively affects PU.

H7b. Organizational capability positively affects PEU.

H8a. Top management support positively affects PU.

H8b. Top management support positively affects PEU.

H9a. Training and education positively affects PU.

H9b. Training and education positively affects PEU.

2.4 Environmental pressures and blockchain adoption

Two constructs characterize the environmental context. Competitive pressure refers to the degree to which an organization perceives the necessity of adopting blockchain in order to maintain strategic relevance and avoid falling behind technologically (Wang *et al.*, 2022). Partner readiness is defined as the degree to which ecosystem actors including suppliers, regulators and technology partners are technically and organizationally prepared to engage with blockchain-based systems (Chittipaka *et al.*, 2023).

The environmental context introduces another layer of complexity because blockchain is not a self-contained technology. Competitive pressure is widely discussed as a driver of innovation adoption because organizations seek to preserve strategic relevance and avoid falling behind technologically (Wang *et al.*, 2022; Malik *et al.*, 2020, 2021). Partner readiness is especially important for blockchain because the technology depends heavily on ecosystem participation, shared standards and coordinated data exchange. In blockchain settings, adoption often becomes feasible only when external actors are prepared to engage, and prior studies show that the success of blockchain initiatives depends on the technical and organizational preparedness of ecosystem partners (Chittipaka *et al.*, 2023; Ruangkanjanases *et al.*, 2022). Research also suggests that adoption readiness is shaped by ecosystem preparedness and institutional pressures that increase the perceived necessity of process change (Behl *et al.*, 2024; Amanollahnejad *et al.*, 2026). In financial institutions, where coordination with regulators, partners and technology providers is critical, environmental factors should therefore be treated as part of a broader contextual process rather than as isolated external triggers (Wong *et al.*, 2020a; Benchis *et al.*, 2025). Competitive pressure is accordingly expected to directly increase blockchain adoption, while partner readiness should exert an even stronger direct effect because blockchain implementation depends on coordinated external participation.

H10. Competitive pressure positively affects blockchain adoption.

H11. Partner readiness positively affects blockchain adoption.

2.5 TAM relationships in a financial-services context

In this study, blockchain adoption is defined as the degree to which professionals in financial institutions intend to accept and use blockchain technology as part of their operational and strategic activities (Bag *et al.*, 2023). This outcome construct captures the individual's behavioral intention to integrate blockchain into existing work processes, consistent with the intention-based conceptualization used in prior technology adoption research (Davis, 1989; Wider *et al.*, 2025).

TAM explains adoption through PU and PEU. In blockchain contexts, both constructs are important because the technology combines substantial operational promise with substantial implementation difficulty. Prior research shows that PU and PEU influence behavioral

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intention in blockchain-related settings (Hashimy *et al.*, 2023; Nazim *et al.*, 2021; Jena, 2022). However, TAM-based studies often assume that these perceptions emerge independently of context (Wider *et al.*, 2025). This assumption weakens explanatory power in institutional settings, especially in financial organizations, where user evaluations are shaped by technological features, managerial support and ecosystem conditions rather than by individual cognition alone. This limitation becomes sharper when blockchain adoption is viewed as a multistage process involving awareness, evaluation, implementation and operationalization (Bag *et al.*, 2023; Lu *et al.*, 2024). Evidence from financial services suggests that blockchain's relevance lies not only in its technical architecture but also in its capacity to reduce transaction delays, lower intermediation costs and support alternative operational models in value transfer processes (Christodoulou *et al.*, 2024). In such high-stakes environments, PU should play the dominant role because adoption decisions are driven primarily by performance, efficiency and risk-related considerations rather than by usability alone (Khalil *et al.*, 2022; Wider *et al.*, 2025). PEU, while still important, is expected to exert a weaker direct effect on adoption, with its primary role lying in shaping PU, consistent with the original TAM proposition (Davis, 1989).

H12. PU positively affects blockchain adoption.

H13. PEU positively affects blockchain adoption.

H14. PEU positively affects PU.

2.6 Mechanism-based integration and mediation logic

Taken together, the literature reveals a fundamental theoretical inconsistency in current explanations of blockchain adoption. TOE-based studies provide contextual richness but often fail to explain the cognitive mechanisms linking context to behavior, whereas TAM-based studies clarify cognition while overlooking the institutional setting in which perceptions are formed. As a result, blockchain adoption is frequently explained either structurally without cognition or cognitively without context. This limitation is particularly important because blockchain adoption is not a single-stage event, but a layered process involving evaluations of usability, value and feasibility. Existing studies have largely emphasized direct effects or single mediators, leaving the sequential and interdependent nature of adoption underexplored (Ghode *et al.*, 2020; Happy *et al.*, 2023). The literature therefore points to a clear gap (AlShamsi *et al.*, 2022). To address it, the present study proposes a mechanism-based integration of TOE and TAM in which contextual conditions influence adoption through PEU and PU, consistent with blockchain assimilation research (Purusottama *et al.*, 2025). Within this perspective, mediation is not peripheral but central. Technological, organizational and environmental conditions are expected to shape adoption indirectly by influencing users' evaluations of value and usability, while the TAM logic also implies a sequential pathway in which ease of use shapes usefulness before adoption behavior emerges.

The mediation hypotheses rest on an explicit theoretical rationale grounded in both frameworks and in the operational realities of financial institutions. Technological attributes such as relative advantage, compatibility and information security do not trigger adoption automatically; they must first be interpreted by decision-makers as evidence that the technology will improve performance or reduce effort (Davis, 1989; Gangwar *et al.*, 2015). In financial institutions, this interpretive step is institutionalized: proposed technologies are evaluated through business cases, risk assessments and compliance reviews. In these evaluations, expected usefulness, reflected in efficiency gains, auditability and fraud reduction, constitutes the decisive criterion, while implementation difficulty determines whether those benefits are perceived as attainable (Khalil *et al.*, 2022; Jena, 2022). Empirically, prior blockchain studies report that technological characteristics shape adoption intentions indirectly through PU and PEU rather than directly (Ghode *et al.*, 2020; Wong *et al.*, 2020b; Kamble *et al.*, 2019).

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Accordingly, PU and PEU are hypothesized to transmit the effects of technological factors on blockchain adoption. A parallel logic applies to organizational factors: capabilities, executive support and training influence adoption by changing how useful and how manageable the technology appears to organizational members, rather than by mandating behavior directly (Awa and Ojiabo, 2016; Behl *et al.*, 2024). These arguments motivate the following mediation hypotheses.

H15a. PU mediates the relationship between technological factors and blockchain adoption.

H15b. PEU mediates the relationship between technological factors and blockchain adoption.

H16a. PU mediates the relationship between organizational factors and blockchain adoption.

H16b. PEU mediates the relationship between organizational factors and blockchain adoption.

H17. PEU and PU sequentially mediate the relationship between TOE factors and blockchain adoption.

Figure 1 summarizes the proposed research model and the hypothesized relationships among the TOE dimensions, PEU, PU and blockchain adoption.

3. Methodology

3.1 Survey design, data collection and analysis technique

This study adopts a quantitative research design using a structured survey instrument. The questionnaire was developed on the basis of previously validated scales drawn from the TOE and TAM literature and adapted to the blockchain adoption context in financial institutions. All construct items were measured on a five-point Likert scale anchored at 1 (strongly disagree) and 5 (strongly agree). The survey instrument was pilot-tested with a small group of banking professionals before final administration to assess item clarity and face validity. A five-point Likert format was chosen because it balances measurement sensitivity with respondent burden, reduces the cognitive effort required of busy banking professionals and is the dominant response format in prior TOE- and TAM-based blockchain studies, which facilitates comparability of results (Malik *et al.*, 2021; Khalil *et al.*, 2022). Before full deployment, the instrument was reviewed by academic experts and a small group of banking professionals for clarity, content validity and contextual appropriateness, and minor wording refinements were made on the basis of this pre-test.

The target population comprises professionals employed in commercial banks operating in Türkiye, specifically individuals with direct involvement in technology strategy, digital transformation, operations or risk management. Türkiye provides a contextually suitable setting for this inquiry. Its banking sector is technologically advanced, centrally regulated and actively engaged in evaluating emerging digital infrastructures including blockchain. The sector operates under the oversight of the Banking Regulation and Supervision Agency (BDDK) and includes both state-owned and privately held commercial banks that differ in their institutional resources, risk appetite and strategic orientation toward innovation. This heterogeneity makes the Turkish banking sector a theoretically productive environment for examining how contextual conditions interact with perceptual mechanisms to shape adoption decisions. The study did not aim to cover all banks in Türkiye; rather, it focused on commercial banks, including both state-owned and privately held institutions, because these banks are directly involved in digital transformation, customer-facing financial operations and technology-related decision-making. Geographically, data collection covered bank headquarters and branch networks across multiple regions of Türkiye, including the major

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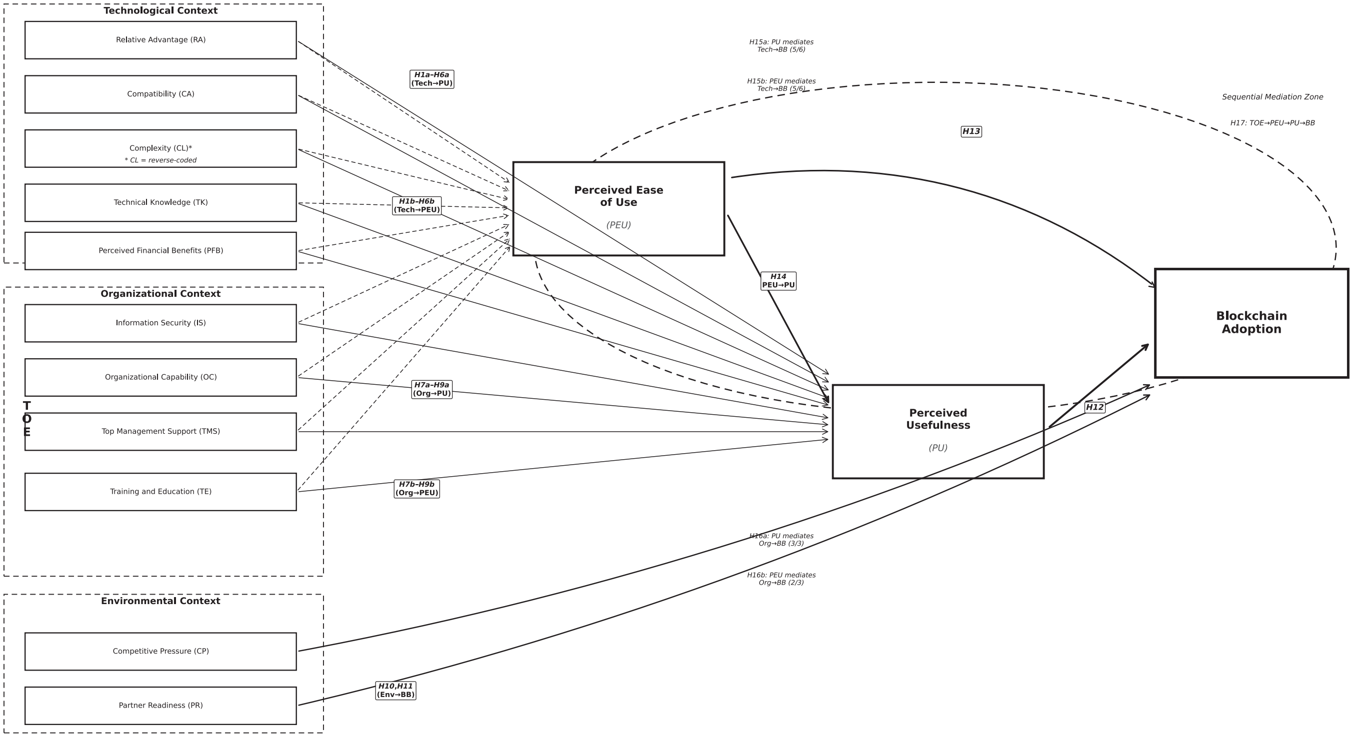

Figure 1. Proposed research model. Source: Authors' own work

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financial centers of Istanbul and Ankara as well as regional branch operations, which mitigates the risk that the findings reflect the practices of a single metropolitan market.

Data were collected through a purposive sampling strategy targeting senior and mid-level professionals in managerial and specialist positions. Survey links were distributed via professional networks, institutional contacts and direct outreach to bank branches and departments. The data collection process yielded 531 completed responses, of which 479 were deemed valid after screening for incomplete submissions, straight-lining patterns and implausible response sequences. The overall response rate was approximately 90.2% of the distributed instruments that reached eligible participants. The final sample of 479 respondents reflects a contextually appropriate and experienced group, with 88.0% reporting more than six years of professional experience in the banking sector. The sample includes participants from both state-owned banks (n = 291, 60.8%) and private commercial banks (n = 188, 39.2%), covering branch managers, commercial portfolio managers and specialists across information technology, digital transformation, operations and risk management functions.

The adequacy of the sample size was evaluated against established guidelines for covariance-based structural equation modeling. Hair *et al.* (2010) recommend a minimum of 200 observations for models of moderate complexity. With 479 valid cases, the final sample substantially exceeds this commonly cited minimum and was considered adequate in relation to the complexity of the specified 14-construct model, supporting stable parameter estimation and reliable fit assessment.

Covariance-based structural equation modeling (CB-SEM) was selected as the primary analytical technique. CB-SEM is appropriate for theory-testing research that seeks to assess the fit of a pre-specified theoretical model to empirical data and to examine both direct and indirect effects among latent constructs (Hair *et al.*, 2010). It is preferred over partial least squares SEM (PLS-SEM) in confirmatory contexts where the theoretical model is well developed and global fit assessment is necessary. Given that the present study tests a specific mechanism-based integration of TOE and TAM with sequential mediation, CB-SEM is the more suitable choice. Analyses were conducted using IBM SPSS AMOS. The measurement model was assessed through confirmatory factor analysis, reliability (Cronbach's alpha, composite reliability), convergent validity (average variance extracted) and discriminant validity (Fornell–Larcker criterion and HTMT ratios). Mediation was assessed using bias-corrected bootstrapped confidence intervals based on 5,000 resamples (Hayes, 2018).

4. Analysis and results

4.1 Sample characteristics

The final sample comprised 479 valid responses obtained from senior professionals employed in banks operating in Türkiye. The respondents occupied managerial and specialist positions across key functional areas, including information technology, digital transformation, operations and risk management. Overall, the sample reflects a contextually appropriate and knowledgeable group with direct involvement in technology-related decision-making processes within the banking sector.

Table 1 presents the profile of the survey respondents. The sample is broadly balanced by gender, with 244 female respondents (50.9%) and 231 male respondents (48.2%). Most participants are between 26 and 45 years old (424 respondents, 88.6%), and the majority hold at least a bachelor's degree, with 318 respondents (66.4%) having a bachelor's degree and 107 (22.3%) holding postgraduate qualifications. In professional terms, most respondents occupy managerial or expert roles, particularly branch manager/director, commercial portfolio manager and specialist positions. In addition, 291 respondents (60.8%) work in state-owned banks, while 188 (39.2%) are employed in private banks. Finally, most respondents report substantial sectoral experience, with 422 (88.0%) having more than six years of experience, indicating a knowledgeable and contextually appropriate sample for examining blockchain adoption in financial institutions.

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Table 1. Sample characteristics

Profile	*n*	%
Gender		
Male	231	48.2
Female	244	50.9
Other	4	0.8
Age		
18–25	13	2.7
26–35	190	39.7
36–45	234	48.9
46 and above	42	8.8
Education level		
High school	10	2.1
Associate degree	44	9.2
Bachelor's degree	318	66.4
Postgraduate (MSc/PhD)	107	22.3
Position		
Branch manager	167	34.9
Commercial portfolio manager	160	33.4
Specialist	137	28.6
Other	15	3.1
Type of bank		
State-owned bank	291	60.8
Private bank	188	39.2
Years of experience		
Less than 1 year	21	4.4
1–5 years	36	7.5
6–10 years	164	34.2
11–20 years	174	36.3
21 years and above	84	17.5

Source(s): Authors' own work

4.2 Measurement model

The measurement model was assessed through a series of complementary analyses, including reliability and convergent validity tests, sampling adequacy assessment, exploratory and confirmatory factor analyses and the Fornell–Larcker criterion (Fornell and Larcker, 1981) for discriminant validity. Table 2 presents the reliability and convergent validity results for all constructs included in the measurement model.

As shown in Table 2, the results provide strong evidence of internal consistency reliability and convergent validity across all constructs in the model. Cronbach's alpha values exceed 0.70 for every construct, indicating satisfactory internal consistency, while composite reliability values are also above acceptable thresholds, confirming that the indicators reliably represent their corresponding latent variables. Convergent validity is likewise supported, as all AVE values exceed 0.50, showing that each construct explains more than half of the variance in its indicators. In addition, the standardized factor loadings are generally strong and within acceptable ranges. Overall, these findings indicate that the measurement instrument is stable, precise and appropriate for testing the proposed multiconstruct, mediation-based TOE–TAM framework. To assess the adequacy of the measurement model, Table 3 presents the results of the sampling adequacy, exploratory factor analysis and confirmatory factor analysis.

The results reported in Table 3 provide strong support for the adequacy of the measurement model at both the exploratory and confirmatory stages. The Kaiser–Meyer–

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Table 2. Reliability and convergent validity results

Construct	Items (*n*)	Cronbach's α	AVE	CR
Relative advantage (RA)	4	0.890	0.753	0.924
Compatibility (CA)	4	0.735	0.560	0.835
Complexity (CL)	3	0.773	0.687	0.868
Technical knowledge (TK)	4	0.870	0.720	0.911
Perceived financial benefits (PFB)	4	0.873	0.797	0.922
Information security (IS)	3	0.850	0.691	0.899
Organizational capability (OC)	4	0.846	0.685	0.897
Top management support (TMS)	4	0.817	0.645	0.879
Training and education (TE)	3	0.828	0.745	0.897
Competitive pressure (CP)	5	0.828	0.595	0.880
Partner readiness (PR)	4	0.901	0.772	0.931
Perceived ease of use (PEU)	4	0.912	0.792	0.939
Perceived usefulness (PU)	4	0.873	0.725	0.913
Blockchain adoption (BB)	3	0.841	0.759	0.904

Note(s): Cronbach's alpha >0.70, AVE >0.50 and CR > 0.70. Standardized factor loadings should preferably be $\lambda \geq 0.70$

Source(s): Authors' own work

Olkin statistic indicates meritorious sampling adequacy, while Bartlett's test of sphericity is highly significant, confirming that the correlation matrix is factorable and suitable for latent-structure analysis. The sample-to-item ratio also exceeds recommended thresholds, suggesting stable data for factor extraction and model estimation. At the exploratory stage, the factor structure explains a substantial proportion of total variance. At the confirmatory stage, standardized factor loadings remain generally strong, and the fit indices indicate satisfactory model fit. Overall, these findings support construct validity and justify proceeding to the structural path and mediation analyses. To complement these results, Table 4 presents the Fornell–Larcker matrix for assessing discriminant validity among the study constructs.

Several indicators in Table 3 display standardized loadings between 0.550 and 0.70. These items were deliberately retained rather than trimmed for two reasons. First, following Hair *et al.* (2010), loadings above 0.50 are acceptable when construct-level reliability and validity criteria are satisfied. In the present model, every construct exceeds the recommended thresholds for composite reliability (CR > 0.70) and average variance extracted (AVE >0.50), indicating that the weaker items do not compromise convergent validity at the construct level. Second, consistent with scale-development recommendations emphasizing content validity and adequate coverage of the construct domain (Churchill, 1979; Hinkin, 1998), the affected items were retained because they derive from previously validated scales and capture theoretically relevant aspects of blockchain adoption in financial institutions. Removing them would narrow the conceptual domain of the constructs; for example, dropping the infrastructure-compatibility item would reduce compatibility to a purely experiential notion rather than capturing its fit with existing technological architecture. The relatively modest AVE for compatibility is acknowledged as a measurement limitation, but its convergent and discriminant validity remain acceptable because the construct exceeds the AVE and CR thresholds and is further supported by the Fornell–Larcker criterion and the HTMT analysis reported below.

The Fornell–Larcker results confirm that the constructs are empirically distinct from one another. For each construct, the square root of the AVE is greater than its correlations with all other constructs, satisfying the conventional discriminant validity criterion. This indicates that each latent variable shares more variance with its own indicators than with the other constructs in the model.

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Table 3. Sampling adequacy, exploratory and confirmatory factor analysis results

Variables	EFA loading	CFA loading
Relative advantage		
Blockchain technology will enable us to scale our operational data more effectively	0.867	0.818
Blockchain technology will facilitate access to information anytime and anywhere	0.863	0.809
Blockchain technology will make it easier to manage the information technology infrastructure	0.877	0.837
Blockchain technology will facilitate the sharing of data resources	0.864	0.812
Compatibility		
Blockchain technology is compatible with the existing technology architecture	0.687	0.550
Customization in blockchain technology applications is easy	0.783	0.701
Blockchain technology will be compatible with existing formats, transaction interfaces and data	0.784	0.702
Blockchain technology will expand the scope of personalization	0.734	0.617
Complexity		
Blockchain technology applications may not be compatible with the current infrastructure	0.797	0.654
Blockchain technology may create computer failures and data security vulnerabilities	0.846	0.773
Blockchain technology may be difficult to integrate into complex banking operations	0.843	0.762
Technical knowledge		
Technical workforce and units for blockchain technology are available	0.865	0.831
Consultants for blockchain technology can be accessed easily	0.888	0.875
Technical and service providers already using blockchain technology are accessible	0.867	0.803
Similar technologies have been used successfully in the past	0.769	0.654
Information security		
Transactions carried out through blockchain technology will be secure	0.894	0.836
Information sharing through blockchain technology will be secure	0.902	0.862
Blockchain technology will provide a high level of data security	0.882	0.805
Perceived financial benefits		
Blockchain technology will reduce operational costs	0.805	0.725
Blockchain technology will attract new customers that increase profitability	0.839	0.767
Blockchain technology will reduce transaction costs	0.867	0.833
Blockchain technology will help retain existing customers by increasing profitability	0.812	0.741
Organizational capability		
Access to technical knowledge is available for implementing blockchain technology	0.824	0.751
Access to computers is available for implementing blockchain technology	0.850	0.806
Access to an Internet connection is available for implementing blockchain technology	0.836	0.779
Sufficient capital is available for implementing blockchain technology	0.799	0.709
Top management support		
Top management assigns strategic importance to blockchain technology	0.808	0.744
Top management is willing to take risks related to blockchain technology	0.828	0.776
Top management encourages a culture of transparency and accountability gained through information sharing	0.797	0.704
Top management has demonstrated strong leadership and commitment in adopting information and communication technology innovations in the past	0.780	0.679
Training and education		
Training to be provided on Blockchain Technology will significantly improve understanding of blockchain	0.848	0.737
Training on Blockchain Technology will increase confidence/competence	0.901	0.907
Your organization will provide adequate training on Blockchain Technology	0.839	0.717

(*continued*)

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Table 3. Continued

Variables	EFA loading	CFA loading
Competitive pressure		
Blockchain Technology will provide competitive advantages	0.772	0.720
Your competitors in the industry are in the process of implementing blockchain technology	0.809	0.774
Competitors will become more competitive through the implementation of blockchain technology	0.797	0.748
Competitors will have more advanced processes through the implementation of blockchain technology	0.768	0.669
Competitors will reduce transaction times and costs through the implementation of blockchain technology	0.707	0.595
Partner readiness		
Business partners will be willing to implement blockchain technology	0.874	0.825
Business partners will support blockchain technology	0.882	0.840
Business partners will be willing to change their processes and practices for blockchain technology	0.898	0.871
Business partners have always supported us in information and communication technology initiatives in the past	0.859	0.801
Perceived ease of use		
Blockchain technology will be easy to understand	0.890	0.857
Blockchain technology will be easy to adopt	0.909	0.891
Blockchain technology will be easy to use	0.894	0.849
The features of blockchain technology will be easier than those of other technologies	0.867	0.804
Perceived usefulness		
Blockchain technology will help improve job efficiency	0.830	0.749
Blockchain technology will improve the quality of business operations	0.852	0.786
Blockchain technology will enhance organizational competitiveness	0.874	0.845
Overall, blockchain technology will be useful for my job	0.849	0.802
Blockchain adoption		
Blockchain technology will be used regularly in the future	0.863	0.776
Using blockchain technology will be advantageous	0.885	0.839
The organization will be willing to use blockchain technology	0.866	0.783

Note(s): Kaiser–Meyer–Olkin (KMO): 0.891; Bartlett's test of sphericity (χ^2): 14716.087
Degrees of freedom: 1,378; p-value: <0.001
χ^2: 2326.97; df: 1,234; p-value: <0.001; χ^2/df: 1.886; CFI: 0.922; TLI: 0.912; GFI: 0.901; RMSEA: 0.043; SRMR: 0.053

Source(s): Authors' own work

This result is particularly important because the study includes conceptually related dimensions drawn from both TOE and TAM. Without adequate discriminant validity, it would be difficult to determine whether the effects observed in the structural model reflect genuinely distinct constructs or overlapping measurement domains. The findings in Table 4 therefore strengthen the interpretability of the model by showing that the technological, organizational environmental and perceptual variables remain sufficiently differentiated despite being meaningfully connected. Table 5 presents the heterotrait-monotrait (HTMT) ratio matrix for assessing discriminant validity among the study constructs.

To supplement the Fornell–Larcker criterion, discriminant validity was further assessed using the HTMT ratio, which is a more sensitive indicator particularly for models with conceptually adjacent constructs (Henseler *et al.*, 2015). The HTMT ratio is defined as the mean of all heterotrait–heteromethod correlations relative to the geometric mean of the average monotrait–heteromethod correlations. Values below 0.85 satisfy the conservative

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Table 4. Fornell–Larcker matrix for discriminant validity

	RA	CA	CL	TK	PFB	IS	OC	TMS	TE	CP	PR	PEU	PU	BB
RA	*0.868*													
CA	0.375***	*0.748*												
CL	−0.101*	−0.126*	*0.829*											
TK	0.204**	0.316***	−0.189*	*0.849*										
PFB	0.294**	0.375***	0.003	0.408***	*0.893*									
IS	0.277**	0.279**	−0.003	0.052	0.180*	*0.831*								
OC	0.198*	0.201**	0.006	0.148*	0.170*	0.474***	*0.828*							
TMS	0.149*	0.217**	−0.125*	0.261**	0.182*	0.403***	0.634***	*0.803*						
TE	0.240**	0.294**	−0.155*	0.171*	0.214**	0.289**	0.210**	0.223**	*0.863*					
CP	0.305***	0.248**	−0.087	0.250**	0.245**	0.280**	0.246**	0.221**	0.398***	*0.771*				
PR	0.218**	0.334***	−0.132*	0.364***	0.470***	0.171*	0.237**	0.313***	0.222**	0.189*	*0.879*			
PEU	0.244**	0.281**	−0.295**	0.277**	0.227**	0.199*	0.285**	0.318***	0.336***	0.309***	0.247**	*0.890*		
PU	0.359***	0.298**	0.009	0.184*	0.463***	0.432***	0.298**	0.246**	0.264**	0.301***	0.507***	0.283**	*0.851*	
BB	0.309***	0.308***	−0.006	0.188*	0.518***	0.328***	0.229**	0.241**	0.291**	0.298**	0.479***	0.176*	0.644***	*0.871*

Note(s): Italic diagonal elements are the square roots of the average variance extracted (AVE) for each construct; off-diagonal elements are inter-construct correlations. Discriminant validity is established when each diagonal element exceeds the correlations in its row and column (Fornell and Larcker, 1981)

Source(s): Authors' own work

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Table 5. Heterotrait-monotrait (HTMT) ratio matrix for discriminant validity

	RA	CA	CL	TK	PFB	IS	OC	TMS	TE	CP	PR	PEU	PU	BB
RA														
CA	0.465													
CL	0.122	0.168												
TK	0.232	0.396	0.230											
PFB	0.334	0.469	0.004	0.468										
IS	0.319	0.354	0.004	0.061	0.209									
OC	0.229	0.256	0.007	0.173	0.198	0.560								
TMS	0.175	0.281	0.157	0.310	0.215	0.484	0.763							
TE	0.280	0.378	0.194	0.202	0.252	0.345	0.251	0.271						
CP	0.356	0.319	0.109	0.295	0.289	0.335	0.295	0.269	0.482					
PR	0.244	0.412	0.158	0.412	0.530	0.196	0.272	0.365	0.257	0.219				
PEU	0.271	0.344	0.351	0.311	0.254	0.226	0.325	0.368	0.387	0.357	0.273			
PU	0.408	0.373	0.011	0.211	0.531	0.502	0.347	0.291	0.311	0.355	0.572	0.318		
BB	0.357	0.393	0.007	0.220	0.604	0.388	0.272	0.291	0.349	0.358	0.551	0.201	0.752	

Source(s): Authors' own work

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threshold; values below 0.90 satisfy the liberal threshold. As reported in Table 5, all HTMT values for the 14 constructs fall below the conservative threshold of 0.85. The highest value is observed for the OC–TMS pair (HTMT = 0.763), which remains well within acceptable limits. These results corroborate the Fornell–Larcker findings and confirm that all constructs in the model maintain adequate discriminant validity, establishing a strong psychometric foundation for the subsequent structural model analysis.

4.3 Common method bias assessment

Given that the data were collected through a single self-report survey instrument administered at one point in time, common method bias (CMB) represents a potential concern that could inflate correlations among constructs and distort structural path estimates (Podsakoff *et al.*, 2003). To assess the extent of this threat, Harman's single-factor test was conducted by entering all scale items into an exploratory factor analysis and examining whether a single factor accounted for a majority of the total variance. The results show that the first unrotated factor accounts for 29.7% of total variance, which is substantially below the 50% threshold commonly used as an indicator of serious common method contamination. This provides initial evidence that CMB is unlikely to be a major source of bias in the present dataset. In addition, procedural measures were taken during data collection to reduce the likelihood of CMB, including assuring respondents of the anonymity and confidentiality of their responses, randomizing item presentation where possible and minimizing contextual cues that might anchor responses across constructs. While these steps do not eliminate the concern entirely, particularly given the cross-sectional design, they reduce its severity and provide additional confidence in the validity of the reported relationships.

4.4 Structural model results

Structural equation modeling (SEM) was used to estimate the hypothesized direct, indirect and sequential relationships among the latent constructs. SEM is appropriate for assessing theoretically specified relationships among multiple constructs while accounting for measurement error (Hair *et al.*, 2010). Consistent with established practice, the measurement model was first evaluated for reliability and validity using Cronbach's alpha and factor analysis before the structural relationships were estimated. Figure 2 presents the estimated structural model and the standardized coefficients for the hypothesized relationships.

The overall structural model fit was satisfactory, with χ^2 = 2326.97, df = 1,234, χ^2/df = 1.886, CFI = 0.922, TLI = 0.912, RMSEA = 0.043 and SRMR = 0.053. These values indicate that the hypothesized model provides an acceptable fit to the observed data and supports the use of the proposed TOE–TAM framework for examining blockchain adoption in financial institutions. The specific structural path estimates associated with these relationships are reported in Table 6, which summarizes the effects of the TOE sub-dimensions on PU.

To supplement the fit indices and assess the predictive adequacy of the model, Cohen's f^2 effect sizes were computed for the primary structural paths (Cohen, 1988). PU yielded the largest effect on blockchain adoption (f^2 = 0.71, large effect), supporting the interpretation that PU is the primary adoption mechanism in the model. PEU showed a small-to-medium effect on PU (f^2 = 0.09), consistent with its role as a foundational precondition rather than a co-equal predictor. The R^2 values for the three endogenous constructs were: PEU (R^2 = 0.34), PU (R^2 = 0.59) and blockchain adoption (R^2 = 0.61). These values indicate that the proposed TOE–TAM framework accounts for substantial variance in each outcome and supports the predictive relevance of the mechanism-based integration. The specific structural path estimates are reported in Table 6.

Regarding hypothesis testing, the results confirm significant positive effects on PU from both technological and organizational factors. Among technological predictors, relative advantage (β = 0.359), compatibility (β = 0.298), technical knowledge (β = 0.184), perceived

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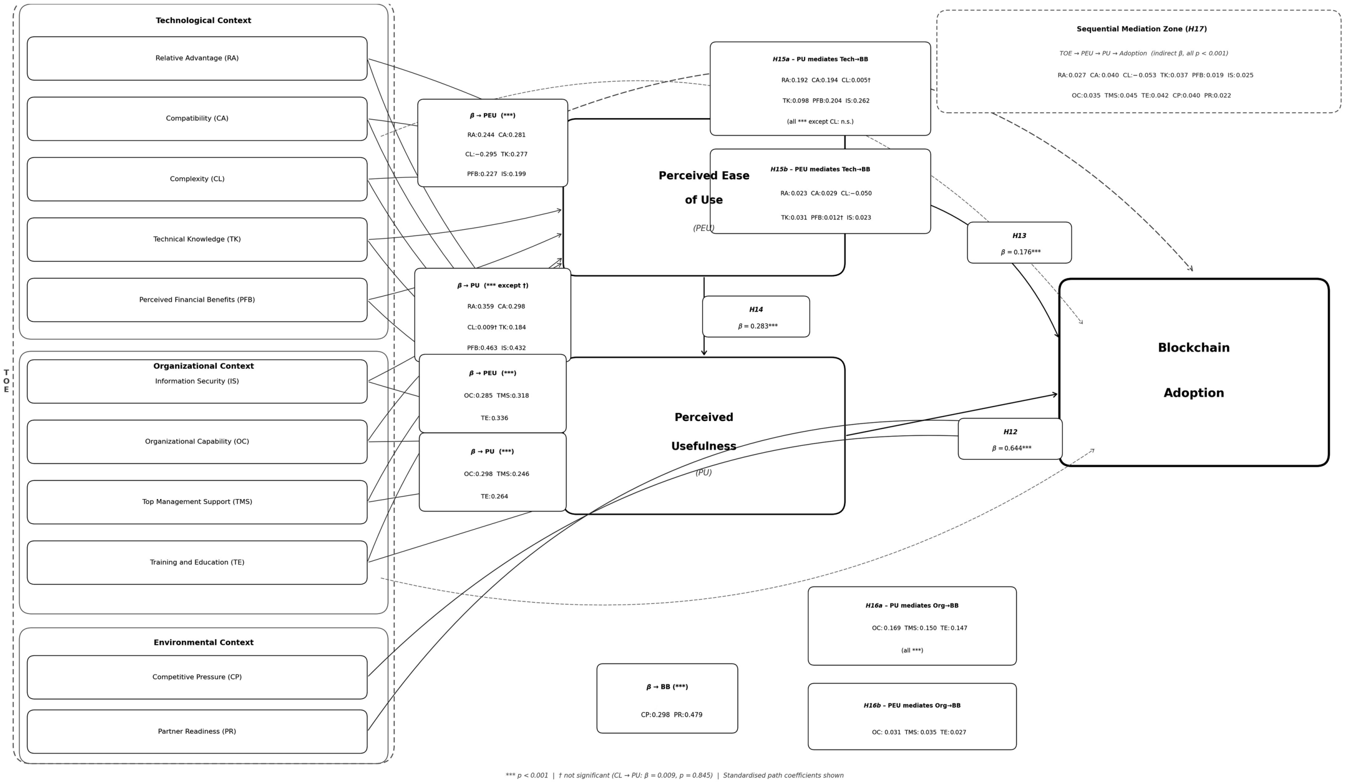

Figure 2. SEM results. Source: Authors' own work

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Table 6. Structural path estimates for TOE sub-dimensions predicting perceived usefulness

Hypothesis	Path	β (std.)	b	SE	*t*	*p*	R^2	Result
H1a	RA → PU	+0.359	+0.313	0.037	+8.402	<0.001	0.129	Supported
H2a	CA → PU	+0.298	+0.321	0.047	+6.829	<0.001	0.089	Supported
H3a	CL → PU	+0.009	+0.008	0.040	+0.196	0.845	0.000	Rejected
H4a	TK → PU	+0.184	+0.155	0.038	+4.083	<0.001	0.034	Supported
H5a	PFB → PU	+0.463	+0.397	0.035	+11.413	<0.001	0.214	Supported
H6a	IS → PU	+0.432	+0.424	0.041	+10.470	<0.001	0.187	Supported
H7a	OC → PU	+0.298	+0.268	0.039	+6.807	<0.001	0.089	Supported
H8a	TMS → PU	+0.246	+0.242	0.044	+5.537	<0.001	0.060	Supported
H9a	TE → PU	+0.264	+0.241	0.040	+5.969	<0.001	0.069	Supported

Source(s): Authors' own work

financial benefits (β = 0.463) and information security (β = 0.432) all reached significance (all $p < 0.001$), supporting H1a, H2a, H4a, H5a and H6a. Among organizational predictors, organizational capability (β = 0.298), top management support (β = 0.246) and training and education (β = 0.264) also showed significant positive effects (all $p < 0.001$), supporting H7a, H8a and H9a. Perceived financial benefits and information security emerged as the strongest determinants, indicating that blockchain is most likely to be viewed as useful when associated with tangible economic value and stronger transaction security. By contrast, complexity did not significantly predict PU (β = 0.009, $p = 0.845$), leading to the rejection of H3a. This result suggests that respondents may still recognize blockchain's strategic value even when they perceive it as technically demanding. Overall, these findings provide strong support for H1a to H9a, with the exception of H3a. To complement these results, Table 7 presents the structural path estimates for the TOE sub-dimensions predicting PEU.

Regarding hypothesis testing, the results confirm significant positive effects on PEU. Among technological factors, relative advantage (β = 0.244), compatibility (β = 0.281), technical knowledge (β = 0.277), perceived financial benefits (β = 0.227) and information security (β = 0.199) all produced significant positive effects (all $p < 0.001$), supporting H1b, H2b, H4b, H5b and H6b. Among organizational factors, organizational capability (β = 0.285), top management support (β = 0.318) and training and education (β = 0.336) similarly showed significant positive effects (all $p < 0.001$), supporting H7b, H8b and H9b. Training and education and top management support emerged as the strongest positive determinants of PEU, reflecting the importance of learning support and institutional commitment in reducing perceived effort. By contrast, complexity had a significant negative effect on PEU (β = −0.295, $p < 0.001$), supporting H3b and supporting the interpretation that

Table 7. Structural path estimates for TOE sub-dimensions predicting perceived ease of use

Hypothesis	Path	β (std.)	b	SE	*t*	*p*	R^2	Result
H1b	RA → PEU	+0.244	+0.259	0.047	+5.485	<0.001	0.059	Supported
H2b	CA → PEU	+0.281	+0.368	0.058	+6.400	<0.001	0.079	Supported
H3b	CL → PEU	−0.295	−0.317	0.047	−6.750	<0.001	0.087	Supported
H4b	TK → PEU	+0.277	+0.284	0.045	+6.295	<0.001	0.077	Supported
H5b	PFB → PEU	+0.227	+0.238	0.047	+5.097	<0.001	0.052	Supported
H6b	IS → PEU	+0.199	+0.238	0.054	+4.435	<0.001	0.040	Supported
H7b	OC → PEU	+0.285	+0.313	0.048	+6.487	<0.001	0.081	Supported
H8b	TMS → PEU	+0.318	+0.381	0.052	+7.324	<0.001	0.101	Supported
H9b	TE → PEU	+0.336	+0.375	0.048	+7.789	<0.001	0.113	Supported

Source(s): Authors' own work

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implementation difficulty remains a meaningful barrier. Overall, these findings provide strong support for H1b to H9b. Building on these results, Table 8 presents the direct effects of environmental factors and TAM constructs on blockchain adoption.

Both environmental factors were found to have statistically significant positive effects on blockchain adoption. Competitive pressure positively influenced blockchain adoption ($\beta = 0.298$, $p < 0.001$), supporting H10, while partner readiness also exerted a significant positive effect ($\beta = 0.479$, $p < 0.001$), supporting H11. Partner readiness emerged as the stronger environmental predictor, indicating that although external competition may encourage financial institutions to pursue blockchain initiatives, the actual preparedness of ecosystem partners plays a more decisive role in translating interest into adoption. This is especially important in blockchain contexts, where implementation depends heavily on interorganizational coordination. A similarly strong pattern emerged for the TAM-related paths. PU had the strongest direct effect on blockchain adoption ($\beta = 0.644$, $p < 0.001$), supporting H12 and explaining a substantial proportion of the variance in blockchain adoption ($R^2 = 0.414$). PEU also had a significant positive effect ($\beta = 0.176$, $p < 0.001$), supporting H13, although its impact was weaker. In addition, PEU significantly enhanced PU ($\beta = 0.283$, $p < 0.001$), supporting H14. Overall, these findings provide strong support for H10 to H14. Building on these findings, Table 9 presents the mediation effects of PU in the relationship between technological factors and blockchain adoption.

Tables 9 and 10 test H15a and H15b, Tables 11 and 12 test H16a and H16b and Table 13 tests the sequential mechanism proposed in H17; each table is therefore directly aligned with a hypothesized relationship. PU was found to be a central explanatory mechanism linking most technological factors to blockchain adoption. Significant indirect effects were observed for relative advantage (indirect effect = 0.192), compatibility (indirect effect = 0.194), technical knowledge (indirect effect = 0.098), perceived financial benefits (indirect effect = 0.204) and information security (indirect effect = 0.262). These findings indicate that technological factors encourage blockchain adoption primarily by increasing the extent to which blockchain is perceived as useful for financial operations, with information security and perceived financial benefits producing the strongest indirect effects. By contrast, complexity did not show a significant indirect effect through PU (indirect effect = 0.005). Information security and technical knowledge exhibited full mediation, whereas relative advantage, compatibility and perceived financial benefits showed partial mediation. Overall, H15a is largely supported, with complexity representing the only unsupported pathway. To complement these findings, Table 10 presents the mediation effects of PEU in the relationship between technological factors and blockchain adoption.

PEU was also found to mediate the relationship between several technological factors and blockchain adoption, although more selectively than PU. Significant indirect effects were observed for relative advantage (indirect effect = 0.023), compatibility (indirect effect = 0.029), technical knowledge (indirect effect = 0.031) and information security (indirect effect = 0.023), indicating that these technological factors partly influence blockchain adoption by shaping how understandable and manageable blockchain appears to users.

Table 8. Environmental effects, TAM relationships and blockchain adoption

Hypothesis	Path	β (std.)	b	SE	t	p	R^2	Result
H10	CP → BB	+0.298	+0.296	0.043	+6.817	<0.001	0.089	Supported
H11	PR → BB	+0.479	+0.457	0.038	+11.918	<0.001	0.229	Supported
H12	PU → BB	+0.644	+0.644	0.035	+18.366	<0.001	0.414	Supported
H13	PEU → BB	+0.176	+0.144	0.037	+3.905	<0.001	0.031	Supported
H14	PEU → PU	+0.283	+0.232	0.036	+6.432	<0.001	0.080	Supported

Source(s): Authors' own work

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Table 9. Mediation of perceived usefulness in the relationship between technological factors and blockchain adoption

Path	(Total β)	(X → PU)	(PU → BB)	Indirect	Boot SE	BCa 95% CI	(β)	*p*	Mediation
RA → PU → BB	+0.309	+0.359	+0.612	0.192	0.028	[0.140, 0.253]	+0.089	0.047	Partial
CA → PU → BB	+0.308	+0.298	+0.606	0.194	0.036	[0.129, 0.273]	+0.127	<0.001	Partial
CL → PU → BB	−0.006	+0.009	+0.644	0.005	0.027	[−0.050, 0.057]	+0.024	0.501	No mediation
TK → PU → BB	+0.188	+0.184	+0.630	0.098	0.028	[0.047, 0.154]	+0.066	0.064	Full
PFB → PU → BB	+0.518	+0.463	+0.514	0.204	0.027	[0.153, 0.260]	+0.321	<0.001	Partial
IS → PU → BB	+0.328	+0.432	+0.617	0.262	0.036	[0.197, 0.341]	+0.070	0.061	Full

Note(s): Mediation was assessed using bias-corrected bootstrapped confidence intervals based on 5,000 resamples (Hayes, 2018), complemented by the classical Baron and Kenny (1986) logic. Following the typology of Zhao *et al.* (2010), mediation is classified according to the joint pattern of indirect and direct effects. Indirect-only (full) mediation is inferred when the indirect effect is significant while the direct effect is not. Complementary (partial) mediation is inferred when both the indirect and direct effects are significant and point in the same direction. All classifications reported below follow this bootstrap-based standard rather than relying solely on the causal-steps approach. Indirect-effect significance was assessed using bias-corrected 95% bootstrap confidence intervals based on 5,000 resamples. An indirect effect was considered significant when the confidence interval did not include zero. Direct-effect significance is reported in the *p* column

Source(s): Authors' own work

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Table 10. Mediation of perceived ease of use in the relationship between technological factors and blockchain adoption

Path	(Total β)	(X → PEU)	(PEU → BB)	Indirect	Boot SE	BCa 95% CI	(β)	*p*	Mediation
RA → PEU → BB	+0.309	+0.244	+0.107	0.023	0.012	[0.003, 0.050]	+0.265	<0.001	Partial
CA → PEU → BB	+0.308	+0.281	+0.097	0.029	0.016	[0.001, 0.066]	+0.290	<0.001	Partial
CL → PEU → BB	−0.006	−0.295	+0.191	−0.050	0.016	[−0.087, −0.023]	+0.068	0.167	Full
TK → PEU → BB	+0.188	+0.277	+0.134	0.031	0.014	[0.008, 0.063]	+0.130	0.003	Partial
PFB → PEU → BB	+0.518	+0.227	+0.062	0.012	0.009	[−0.002, 0.035]	+0.504	<0.001	No mediation
IS → PEU → BB	+0.328	+0.199	+0.115	0.023	0.011	[0.005, 0.049]	+0.302	<0.001	Partial

Note(s): Indirect-effect significance was assessed using bias-corrected 95% bootstrap confidence intervals based on 5,000 resamples. An indirect effect was considered significant when the confidence interval did not include zero. Direct-effect significance is reported in the *p* column

Source(s): Authors' own work

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Table 11. Mediation of perceived usefulness in the relationship between organizational factors and blockchain adoption

Path	(Total β)	(X → PU)	(PU → BB)	Indirect	Boot SE	BCa 95% CI	(β)	*p*	Mediation
OC → PU → BB	+0.229	+0.298	+0.631	0.169	0.029	[0.119, 0.235]	+0.043	0.248	Full
TMS → PU → BB	+0.241	+0.246	+0.622	0.150	0.034	[0.088, 0.221]	+0.091	0.024	Partial
TE → PU → BB	+0.291	+0.264	+0.609	0.147	0.030	[0.094, 0.209]	+0.131	<0.001	Partial

Note(s): Indirect-effect significance was assessed using bias-corrected 95% bootstrap confidence intervals based on 5,000 resamples. An indirect effect was considered significant when the confidence interval did not include zero. Direct-effect significance is reported in the *p* column

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Table 12. Mediation of perceived ease of use in the relationship between organizational factors and blockchain adoption

Path	(Total β)	(X → PEU)	(PEU → BB)	Indirect	Boot SE	BCa 95% CI	(β)	*p*	Mediation
OC → PEU → BB	+0.229	+0.285	+0.121	0.031	0.015	[0.006, 0.064]	+0.193	<0.001	Partial
TMS → PEU → BB	+0.241	+0.318	+0.111	0.035	0.017	[0.004, 0.072]	+0.202	<0.001	Partial
TE → PEU → BB	+0.291	+0.336	+0.088	0.027	0.017	[−0.002, 0.064]	+0.259	<0.001	No mediation

Note(s): Indirect-effect significance was assessed using bias-corrected 95% bootstrap confidence intervals based on 5,000 resamples. An indirect effect was considered significant when the confidence interval did not include zero. Direct-effect significance is reported in the *p* column

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Table 13. Sequential mediation results for TOE dimensions through perceived ease of use and perceived usefulness on blockchain adoption

Path	(X → PEU)	(PEU → PU)	(PU → BB)	Seq. indirect	Boot SE	BCa 95% CI	Sequential indirect effect
RA → PEU → PU → BB	+0.244	+0.207	+0.616	0.0272	0.0090	[0.0128, 0.0483]	<0.001
CA → PEU → PU → BB	+0.281	+0.216	+0.613	0.0400	0.0126	[0.0194, 0.0691]	<0.001
CL → PEU → PU → BB	−0.295	+0.312	+0.647	−0.0526	0.0126	[−0.0841, −0.0329]	<0.001
TK → PEU → PU → BB	+0.277	+0.251	+0.636	0.0373	0.0112	[0.0191, 0.0638]	<0.001
PFB → PEU → PU → BB	+0.227	+0.187	+0.522	0.0190	0.0069	[0.0082, 0.0359]	0.001
IS → PEU → PU → BB	+0.199	+0.205	+0.620	0.0248	0.0087	[0.0112, 0.0461]	0.0012
OC → PEU → PU → BB	+0.285	+0.215	+0.635	0.0351	0.0110	[0.0178, 0.0624]	<0.001
TMS → PEU → PU → BB	+0.318	+0.227	+0.629	0.0448	0.0132	[0.0229, 0.0755]	<0.001
TE → PEU → PU → BB	+0.336	+0.219	+0.619	0.0416	0.0123	[0.0217, 0.0718]	<0.001
CP → PEU → PU → BB	+0.309	+0.210	+0.617	0.0396	0.0125	[0.0193, 0.0692]	<0.001
PR → PEU → PU → BB	+0.247	+0.167	+0.546	0.0215	0.0080	[0.0092, 0.0413]	0.0012

Source(s): Authors' own work

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The most theoretically notable pattern concerns complexity, which shows a significant negative indirect effect through PEU (indirect effect = −0.050), indicating full mediation. This provides evidence that complexity weakens blockchain adoption by making the technology appear harder to use rather than by directly lowering its perceived value. By contrast, perceived financial benefits do not show a significant indirect effect through PEU (indirect effect = 0.012). Overall, H15b is partially supported, as PEU mediates four of the six technological pathways and fully transmits the effect of complexity. Extending these findings to the organizational context, Table 11 presents the mediation effects of PU in the relationship between organizational factors and blockchain adoption.

PU was found to significantly mediate the relationship between all three organizational factors and blockchain adoption. Significant indirect effects were observed for organizational capability (indirect effect = 0.169), top management support (indirect effect = 0.150) and training and education (indirect effect = 0.147). These findings indicate that organizational conditions influence blockchain adoption not only by creating structural readiness but also by shaping the extent to which respondents perceive blockchain as useful for financial operations.

The mediation pattern, however, differs across the three organizational dimensions. Organizational capability exhibits indirect-only (full) mediation under the Zhao *et al.* (2010) typology: its direct effect on adoption is not significant once PU is modeled, indicating that its influence is transmitted predominantly through PU. By contrast, top management support and training and education show partial mediation, suggesting that usefulness explains an important share of their influence, but not all of it. This implies that organizational capability primarily enhances adoption by strengthening value recognition, whereas top management support and training may additionally influence blockchain adoption through other mechanisms such as legitimacy, confidence or usability. Overall, these findings provide strong support for H16a. To complement these findings, Table 12 presents the mediation effects of PEU in the relationship between organizational factors and blockchain adoption.

PEU was found to mediate the relationship between some organizational factors and blockchain adoption, although its mediating role is weaker than that of PU. Significant indirect effects were observed for organizational capability (indirect effect = 0.031) and top management support (indirect effect = 0.035), indicating partial mediation in both cases. These findings suggest that stronger internal capability and visible managerial commitment can enhance blockchain adoption partly by making the technology appear easier to understand and use, thereby supporting early-stage cognitive evaluations by reducing uncertainty and perceived effort.

A different pattern emerges for training and education, whose indirect effect through PEU is not clearly supported by the bootstrap results (indirect effect = 0.027). Because the confidence interval includes zero, the indirect effect is not statistically significant, and no mediation is inferred for this pathway. Nevertheless, the positive point estimate suggests that this pathway may warrant re-examination in future studies with different samples or longitudinal designs, particularly because training may improve ease-of-use perceptions even though its indirect association with adoption was not statistically significant in the current sample. One possible interpretation is that training contributes more strongly to value recognition than to ease-of-use-based behavioral change. Overall, these findings provide partial support for H16b. Table 13 presents the sequential mediation results for the TOE dimensions through PEU and PU on blockchain adoption.

The results provide strong support for the sequential mediation mechanism proposed in H17. All 11 TOE-related dimensions exhibit significant indirect effects on blockchain adoption through the full PEU → PU → blockchain adoption chain, thereby supporting H17. Positive and significant sequential indirect effects were observed for relative advantage (0.0272) compatibility (0.0400), technical knowledge (0.0373), perceived financial benefits (0.0190), information security (0.0248), organizational capability (0.0351), top management support (0.0448), training and education (0.0416),

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competitive pressure (0.0396), and partner readiness (0.0215). These findings indicate that contextual factors shape blockchain adoption not only directly or through isolated mediators, but also through a layered cognitive process in which respondents first evaluate whether blockchain appears manageable, then infer its usefulness and finally translate these evaluations into adoption behavior. Complexity shows a significant negative sequential indirect effect (−0.0526), indicating that higher perceived complexity is associated with lower adoption through reduced ease-of-use and usefulness evaluations by lowering ease of use and usefulness. Overall, the findings provide support for the integrated TOE–TAM framework as a staged, interdependent adoption process.

5. Discussion

This study shows that blockchain adoption in financial institutions is better explained as a mechanism-based cognitive process than as the direct outcome of isolated contextual conditions. Although prior studies have used the TOE framework to identify technological, organizational and environmental drivers of adoption, many of them implicitly treat these factors as direct predictors of adoption outcomes (Behl *et al.*, 2024; Bag *et al.*, 2023; Chittipaka *et al.*, 2023; Pandey and Pathak, 2025). The present findings refine this view by showing that TOE dimensions are translated into adoption behavior through perceptual mechanisms, particularly PEU and PU. This result is consistent with calls for more integrated explanations of blockchain adoption, as earlier studies have noted that the literature remains fragmented across drivers, contexts and outcomes without adequately explaining the cognitive process through which adoption decisions are formed (Ghode *et al.*, 2020; Happy *et al.*, 2023). Theoretically, this means that TOE should not be interpreted only as a structural framework listing adoption conditions; rather, it can also be understood as a contextual foundation that shapes user cognition before adoption behavior emerges.

The strongest cognitive mechanism identified in the study is PU, which exerts a much stronger effect on blockchain adoption than PEU. This finding aligns with TAM, but also refines it. Classical TAM presents PU and PEU as complementary determinants of technology adoption (Davis, 1989). However, recent blockchain and financial-sector studies suggest that value-based evaluations often dominate usability-based evaluations in high-stakes institutional settings (Hashimy *et al.*, 2023; Khalil *et al.*, 2022; Jena, 2022; Nazim *et al.*, 2021). The present findings support this performance-first logic: financial professionals are more likely to support blockchain when they believe it can improve operational efficiency, transparency, security and transaction performance. This is consistent with studies showing that blockchain can reduce settlement delays, lower intermediation costs and strengthen auditability in financial-service processes (Christodoulou *et al.*, 2024; Osmani *et al.*, 2021; Sung and Park, 2021; Lu *et al.*, 2024). Theoretically, the result suggests that TAM operates hierarchically rather than symmetrically in financial institutions: ease of use matters, but mainly because it helps users recognize the technology’s practical value.

The sequential mediation results further clarify how this cognitive hierarchy operates. PEU does not merely function as a weaker parallel predictor of adoption; it acts as an evaluative precondition that strengthens PU before adoption behavior develops. Prior studies have implied this relationship by showing that ease-of-use perceptions contribute to usefulness evaluations in blockchain-related settings (Khalil *et al.*, 2022; Wider *et al.*, 2025). The present study extends this logic by testing the sequential pathway from PEU to PU and then to blockchain adoption across all TOE dimensions. This supports the view that contextual conditions first influence whether blockchain appears manageable, and only then whether it appears valuable. Theoretically, this sequential mechanism helps explain why technically complex technologies may still be adopted in institutional environments: users do not evaluate usability and value separately, but through a staged cognitive process in which manageability supports value recognition.

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The findings also show that TOE dimensions do not operate through identical cognitive pathways. Complexity weakens adoption primarily by reducing PEU, while perceived financial benefits and information security influence adoption mainly through PU. This pattern is consistent with Malik *et al.* (2020, 2021) and Wong *et al.* (2020b), who argue that blockchain complexity constrains diffusion by making the technology appear difficult to manage rather than by eliminating its strategic value. Similarly, the usefulness-based effects of financial benefits and information security align with Deng *et al.* (2022) and Bag *et al.* (2023), who show that cost reduction, security assurance and performance gains are central value signals in blockchain adoption. The theoretical implication is that mediation in blockchain adoption is not uniform. Difficulty-related factors are processed through usability judgments, whereas benefit- and risk-related factors are processed through value judgments. This differentiated pathway logic provides a more precise explanation than single-path or direct-effect adoption models.

Finally, the strong role of partner readiness suggests that blockchain adoption in financial institutions is not only an internal organizational decision but also an ecosystem-dependent process. Partner readiness has a stronger effect on adoption than competitive pressure, suggesting that financial institutions are more influenced by the preparedness of external actors than by market rivalry alone. This finding is consistent with Chittipaka *et al.* (2023), Pandey and Pathak (2025), Benchis *et al.* (2025) and Ruangkanjanases *et al.* (2022), who emphasize that blockchain implementation depends on shared standards, interorganizational coordination, data integration and mutual technical commitment. Theoretically, this result extends TOE by showing that the environmental context should not be reduced to competitive pressure. In network-based technologies such as blockchain, ecosystem readiness functions as a critical adoption condition because the value of implementation depends on coordinated participation across institutional boundaries. Taken together, the findings demonstrate that blockchain adoption is best understood as a staged, context-sensitive and cognitively mediated process in which usability, usefulness and ecosystem readiness jointly shape adoption behavior.

Positioning the proposed mechanism against alternative technology adoption frameworks further clarifies its distinctive contribution. Diffusion of Innovations (DOI) theory (Rogers, 2003) explains adoption through perceived innovation attributes such as relative advantage, compatibility and complexity. However, DOI treats these attributes as directly consequential for adoption without modeling the cognitive process through which they are evaluated. The present findings suggest that these very attributes matter precisely because they are translated into usefulness and ease-of-use judgments before influencing behavior. This distinction is also visible in prior TOE–TAM research, where technological and organizational conditions are linked to PU and PEU, while environmental factors are often treated as direct predictors of adoption (Gangwar *et al.*, 2015). Similarly, research based on the unified theory of acceptance and use of technology (UTAUT) conceptualizes performance expectancy, effort expectancy, social influence and facilitating conditions as key determinants of technology acceptance and use (Venkatesh *et al.*, 2003; Williams *et al.*, 2015). When integrated with TOE, these constructs are often examined alongside broader contextual factors. The mechanism-based account developed here differs in a specific way: rather than adding cognitive constructs beside contextual ones, it orders them theoretically and sequentially, showing that contextual conditions operate through a structured ease-of-use → usefulness sequence. This sequential structure is compatible with the effort-to-performance linkage implied in UTAUT, but the present study formalizes and tests it across all TOE dimensions simultaneously. This is important because recent blockchain adoption research shows that the literature has identified multiple antecedents, consequences, mediators and moderators, but has not fully consolidated the mechanisms through which these factors operate (Happy *et al.*, 2023). Future research could test whether the same sequential mechanism holds when UTAUT constructs replace TAM perceptions as the mediating layer.

5.1 Theoretical implications

This study offers several theoretical implications for blockchain adoption research, extending both TOE and TAM in meaningful ways. The following discussion explicitly identifies what

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the findings contribute, which aspects of the sequential mediation mechanism are novel and how the study advances existing knowledge.

The study advances prior TOE-based blockchain research by repositioning contextual factors as cognitive antecedents rather than merely direct structural predictors. Previous TOE studies have predominantly modeled technological, organizational and environmental conditions as direct independent variables (Behl *et al.*, 2024; Wong *et al.*, 2020a; Chittipaka *et al.*, 2023; Pandey and Pathak, 2025). The present findings show that this direct-effects logic is insufficient for explaining blockchain adoption. Many TOE dimensions exert their effects on adoption primarily through perceptual mechanisms, although some environmental factors retain direct effects because of the interorganizational nature of blockchain adoption. This is a specific and empirically verifiable refinement of the existing literature. Structural readiness is therefore a necessary but insufficient condition for adoption. This reconceptualization moves TOE beyond a descriptive inventory of conditions toward a behaviorally interpretive framework in which contextual factors condition individual cognition rather than simply determine outcomes directly.

The sequential mediation mechanism PEU shaping PU, which is in turn associated with adoption, constitutes a specific theoretical contribution. While researchers have previously combined TOE and TAM by treating perceptions as mediators (Gangwar *et al.*, 2015; Awa and Ojiabo, 2016), the sequential interdependence between the two TAM constructs as part of that mediation chain has rarely been empirically tested across multiple TOE dimensions in blockchain research. The support observed for this chain across all 11 TOE-derived constructs provides robust evidence within the present empirical context. It reframes ease of use not merely as a parallel determinant of adoption, but as a foundational evaluative precondition through which contextual signals are processed before value can be recognized. In the Turkish banking sector, where blockchain must navigate high regulatory scrutiny and conservative institutional cultures, this staged cognitive evaluation is especially relevant: professionals are unlikely to support blockchain unless they first judge it manageable and then evaluate its operational value.

The study refines TAM in high-stakes institutional environments by providing evidence of a hierarchical rather than symmetric relationship between its two core constructs. Classical TAM presents PU and PEU as parallel determinants of behavioral intention (Davis, 1989), a representation also reflected in prior blockchain adoption research (Hashimy *et al.*, 2023; Wider *et al.*, 2025). The present findings challenge this symmetry. In the Turkish banking context, PU emerges as the dominant direct driver of blockchain adoption, whereas PEU has a considerably weaker direct effect and operates primarily by strengthening usefulness perceptions. This asymmetry reflects a theoretically meaningful feature of high-accountability institutions in which adoption decisions are evaluated mainly through performance, efficiency and risk-reduction criteria. The implication is that TAM's relative construct weights are not universal but vary with institutional context, warranting more context-sensitive theorization in future research.

The identification of differentiated cognitive pathways across TOE dimensions constitutes a specific empirical advance over prior studies that have reported more undifferentiated mediation patterns. The finding that complexity operates mainly through perceived ease-of-use perceptions, while having no significant effect on PU, shows that implementation difficulty weakens adoption primarily by making blockchain appear less manageable rather than less valuable. By contrast, information security and financial benefits operate more strongly through usefulness, indicating that security assurance and economic value are interpreted mainly as value signals. A single-path mediation model therefore under-represents the complexity of the adoption process. This differentiation is also consistent with the broader logic of technology adoption assimilation (Purusottama *et al.*, 2025): difficulty is primarily a usability barrier, whereas strategic, security and financial advantages are primarily value signals. Recognizing these asymmetric paths provides a more fine-grained and actionable theory of how contextual conditions translate into adoption behavior in financial institutions.

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5.2 Managerial implications

The findings also offer important practical implications for managers in financial institutions. Implementation efforts should prioritize value communication because PU emerged as the strongest determinant of blockchain adoption. Blockchain should therefore be presented not as a technological experiment, but as a credible operational solution capable of delivering tangible performance gains, including faster settlement, stronger transparency, lower reconciliation costs and reduced transaction friction.

Managers must also address usability barriers that may prevent these benefits from being fully recognized. Since complexity weakens adoption primarily through perceived ease-of-use perceptions, organizations should reduce perceived difficulty through better system design, structured onboarding, user training and pilot projects that allow employees to engage with blockchain in manageable and meaningful ways. In this respect, usability support is not secondary to value communication; rather, it is a necessary condition for translating technological potential into positive user evaluations.

Visible and sustained top management support is equally important. Executive commitment matters not only because it facilitates resource allocation but also because it lowers uncertainty and strengthens institutional confidence in the technology. Training and education should similarly be treated as part of the adoption strategy itself rather than as a post-implementation add-on. Finally, managers should approach blockchain adoption as an ecosystem issue rather than a purely internal initiative. Because partner readiness exerts a stronger effect on adoption than competitive pressure, collaborative adoption, shared standards and stakeholder coordination are likely to be more effective than isolated experimentation.

In the Turkish banking context, these managerial recommendations carry additional institutional specificity. Financial institutions operating under the oversight of the Banking Regulation and Supervision Agency (BDDK) must demonstrate that blockchain implementation is compatible with expectations concerning data security, operational continuity, auditability and consumer protection. Adoption proposals should therefore frame blockchain not only as an efficiency-enhancing technology but also as a governance-supporting infrastructure that can strengthen transaction traceability, identity verification, fraud prevention and regulatory transparency. This framing is particularly important in Türkiye, where banking innovation is closely shaped by regulatory approval, institutional trust and systemic risk considerations. Given that state-owned banks represent the majority of the sample and often operate under more conservative risk mandates and multi-level approval structures, early board-level commitment and visible executive sponsorship are especially important. In addition, the strong role of partner readiness suggests that Turkish banks should avoid isolated blockchain experimentation and instead pursue pilot projects through cooperative sectoral structures. Institutions such as the Turkish Banks Association (TBB) and the Interbank Card Center (BKM) may provide useful platforms for developing shared standards, coordinating technical requirements and strengthening ecosystem readiness. Accordingly, blockchain adoption in Türkiye is most likely to progress when banks align internal managerial commitment with regulatory expectations and interorganizational coordination.

Beyond firm-level management, the findings carry actionable implications for regulators and policymakers in the financial sector. First, because PU is the dominant adoption driver, regulatory bodies such as the BDDK can accelerate responsible adoption by clarifying how blockchain-based processes satisfy existing audit, reporting and consumer-protection requirements: regulatory ambiguity suppresses the perceived value of the technology even when its operational benefits are recognized. Second, the significant role of PEU suggests that supervisory sandboxes and controlled pilot regimes reduce perceived implementation difficulty, and should be expanded from digital banking to blockchain-specific use cases such as interbank settlement, trade finance documentation and digital identity verification. Third, the strong effect of partner readiness indicates that adoption is an ecosystem outcome rather than a single-firm decision; policymakers can therefore generate disproportionate impact by

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sponsoring shared technical standards, interoperability protocols and industry-level consortia through bodies such as the TBB and BKM. Finally, the finding that information security operates through value perceptions implies that security certification schemes for blockchain platforms would function not merely as compliance instruments but as adoption catalysts, strengthening institutional confidence in the technology across the sector.

6. Conclusion

This study examined blockchain adoption in financial institutions by integrating TOE and TAM through a mechanism-based perspective. Blockchain adoption in financial institutions is better understood as a multistage process than as a static organizational decision or the direct outcome of isolated contextual factors. The findings indicate that technological, organizational and environmental conditions are translated into behavioral outcomes through layered cognitive evaluations, rather than producing adoption automatically on their own.

A central conclusion is that PU serves as the dominant direct determinant of blockchain adoption, whereas PEU plays a weaker, though still meaningful, role by shaping PU. The results also show that TOE dimensions do not operate through a single uniform route. Complexity influences adoption primarily through usability-related perceptions, while perceived financial benefits and information security work mainly through value-related evaluations. In addition, the supported sequential mediation mechanism indicates that contextual conditions affect adoption through a coherent chain linking ease of use, usefulness and ultimately adoption behavior.

These findings contribute to the literature by moving beyond an additive TOE–TAM integration and offering a more process-oriented explanation of blockchain adoption. Practical implications are equally clear. Financial institutions should approach adoption as a perception-driven transformation process in which value communication, managerial support, usability enhancement and ecosystem readiness all play decisive roles. Overall, adoption depends less on abstract technological promise than on whether blockchain is interpreted as useful, manageable and organizationally credible.

7. Limitations and future research

This paper is inevitably subject to several limitations. First, the study relies on cross-sectional survey data, which limits strong causal inference, even though the theoretical model is directional and the SEM results are consistent with that logic. Longitudinal research would therefore be valuable for examining whether these perceptual mechanisms remain stable as blockchain initiatives move from pilot stages to deeper institutional implementation. Second, the focus on financial institutions in Türkiye provides an analytically rich context but limits direct generalization to other regulatory and institutional environments. Third, the study uses self-reported perceptual measures, so future research could complement these with objective adoption indicators such as implementation milestones, integration depth or transaction volume. Fourth, blockchain adoption is treated as a broad organizational phenomenon; future studies could distinguish among specific use cases such as remittances, smart contracts or compliance systems. Finally, future work should examine moderators such as digital maturity, institutional trust and regulatory stringency to clarify when the proposed mechanism becomes stronger or weaker.

Declaration of generative AI use

AI-assisted tools were used during manuscript preparation to support language editing, formatting, and literature organization. All scientific content, analytical decisions, interpretation of results and conclusions are the sole responsibility of the authors. No AI tool was used as a substitute for the authors' critical thinking or scientific expertise.

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