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Enhancing Blockchain Utilization Capability in Blockchain Platform: Indonesia's Dynamic Infrastructure and Organizational Factors

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ABSTRACT

This study develops and validates Blockchain Utilization Capability as a novel construct that fundamentally reconceptualizes complex enterprise technology adoption by addressing critical gaps in conventional models that assume direct relationships between antecedents and behavioral intentions. Through cross-sectional survey methodology involving 300 Indonesian SMEs actively engaged with blockchain platforms, we integrate the Technology-Organization-Environment framework with the Technology Acceptance Model, positioning capability as a central mediating mechanism analyzed using PLS-SEM with bootstrapping procedures. Results reveal complete mediation patterns where organizational infrastructure, environmental pressures, technological features, perceived usefulness, and perceived ease of use operate exclusively through capability development rather than directly influencing adoption intentions. Organizational factors demonstrate large effects on capability development, while perceived ease of use exhibits paradoxical negative relationships through suppression mechanisms, with the construct achieving superior predictive performance and explaining substantial variance in adoption intentions. We introduce Capability-Mediated TAM, demonstrating that perceptual beliefs require translation into organizational capabilities before influencing complex technology adoption, bridging previously disconnected frameworks by revealing common capability-building pathways through which diverse antecedents operate, and transforming TOE from a descriptive taxonomy into a dynamic process model. Findings establish that organizations should prioritize systematic capability development through phased approaches emphasizing organizational readiness, formal governance, and cross-functional integration before pursuing production implementations, recognizing capability building as an essential rather than optional pathway to blockchain adoption.

Keywords: Blockchain utilization capability, Technology adoption, TOE.

INTRODUCTION

Blockchain technology has progressed beyond its cryptocurrency origins, revolutionizing organizational strategies in supply chain management, healthcare record security, and financial transaction processing through distributed ledger architectures that eliminate intermediaries while preserving cryptographic consensus verification(Chung et al., 2023; Nguyen, 2016) . Despite substantial infrastructure development and institutional enthusiasm in developed economies, emerging markets confront a paradoxical challenge: while national blockchain ecosystems demonstrate infrastructure maturation—Indonesia's platforms processing massive cryptocurrency transactions serving millions of users small and medium enterprises constituting economic backbones struggle with effective implementation(Albayati et al., 2020; Chen et al., 2022) . These organizations consistently identify infrastructure capability constraints and implementation difficulties as primary barriers, indicating that organizational capability deficiencies rather than technology availability constitute fundamental obstacles to blockchain diffusion in resource-constrained contexts(Duchek, 2020; Makhloufi et al., 2021) .

This capability challenge reveals critical gaps in blockchain adoption scholarship. Current research emphasizes organizational adoption intentions rather than examining actual utilization effectiveness, creating an adoption-utilization gap in literature (Chang et al., 2023; Kimberly & Evanisko, 1981; Tortorella et al., 2020). Theoretical inadequacies pervade dominant frameworks: Technology-Organization-Environment models treat adoption as organizational decisions without explaining capability development processes (L. G. Tornatzky, 1992; Zhong & Moon, 2023), while Technology Acceptance Model focuses on individual perceptions without accounting for organizational prerequisites enabling those perceptions (Davis et al., 1989, 1992). This inadequacy stems from blockchain's distinctive characteristics differentiating it fundamentally from conventional information technologies demanding entirely new organizational competencies in cryptographic validation, algorithmic trust mechanisms, and multi-party ecosystem coordination that existing constructs cannot adequately capture(Biswas & Dasgupta, 2020; Longo et al., 2022) . Empirical literature reflects theoretical confusion through persistent inconsistencies where technology, organizational, and environmental factors demonstrate contradictory effects across contexts, suggesting systematic omission of mediating mechanisms scholars have yet to identify properly (Afedzi et al., 2025; Avison, 2016).

The present study addresses deficiencies by reconceptualizing blockchain adoption through organizational capability development, integrating ne theory with capability-based perspectives beyond binary acceptance frameworks(Grant, 1996; Schuetz & Venkatesh, 2020) . Central theoretical contribution introduces Blockchain Utilization Capability as a higher-order organizational construct representing the capacity to implement, optimize, and sustain blockchain within operational frameworks through four interconnected dimensions: change management capability enabling process reconfiguration for distributed architectures, infrastructure readiness capability encompassing technical competency for deployment and maintenance, implementation capability involving project management expertise for solution deployment, and system integration capability facilitating seamless connection with existing systems and external networks(Munoz-Penas et al., 2024). What distinguishes this construct from generic information technology capability frameworks is specificity to blockchain's unique requirements—distributed consensus management, cryptographic protocol expertise, and inter-organizational coordination mechanisms absent in conventional implementations (Biswas & Dasgupta, 2020; Longo et al., 2022). Blockchain Utilization Capability functions as critical mediating mechanism between macro-level environmental pressures and micro-level individual acceptance behaviors, where organizational capability investments create technical infrastructure and knowledge bases directly reducing complexity through training and system design, demonstrating tangible operational benefits through pilot implementations, and establishing algorithm-based trust through transparent cryptographic validation processes (Ali et al., 2021; Yapa et al., 2024). This mediation logic explains why previous research found inconsistent relationships between environmental factors and adoption outcomes: scholars examined direct effects while ignoring organizational transformation processes through which environmental pressures translate into user acceptance(Gagan Deep, 2023; Nikopoulou et al., 2023) .

Empirical investigation tests theoretical propositions through multi-platform examination of Indonesian blockchain ecosystems, sampling organizations across cryptocurrency exchanges (Indodax, Tokocrypto), agricultural supply chain platforms, and digital payment systems to capture capability requirement variation across application domains (Jstor, 2020; Niankara & Traoret, 2023). Financial platforms emphasize security and regulatory compliance capabilities, supply chain implementations require inter-organizational integration and traceability competencies, and payment systems demand scalability with user experience optimization—heterogeneity allowing examination of not only whether capability mediation occurs but how capability configurations vary across contexts with different functional demands. Using structural equation modeling techniques appropriate for formative constructs and predictive relevance assessment, analysis demonstrates Blockchain Utilization Capability mediates substantial portions of environmental effects on technology acceptance while explaining considerable variance in adoption outcomes. Platform-specific analyses reveal important differences in capability requirement patterns across application domains, with some capabilities proving universally critical while others demonstrate context-dependent importance. These findings advance theory by extending capability-based perspectives into blockchain contexts while providing practical guidance for platform developers designing capability-building features, policymakers crafting infrastructure and educational initiatives addressing capability gaps, and enterprise managers identifying critical capability investments for successful implementation (Gagan Deep, 2023; Nikopoulou et al., 2023). By explicating organizational transformation processes through which environmental pressures translate into sustained technology utilization, this research contributes to theoretical understanding of blockchain adoption dynamics and evidence-based policy development for digital transformation in resource-constrained environments.

CONCEPTUAL FRAMEWORK AND HYPOTHESIS DEVELOPMENT

Conceptual Framework

Blockchain utilization capability requires multidimensional operationalization grounded in the Technology-Organization-Environment (TOE) Framework. The technology dimension incorporates relative advantage from innovation diffusion theoryL. Tornatzky & Fleischer, (1990) , measured through business process efficiency, transaction speed, and data security improvements. Blockchain complexity evaluation examines implementation difficulty, resource requirements, and consensus algorithm sophistication following the technology adoption framework. Technology compatibility assesses integration capability with existing IT infrastructure, representing a critical factor in blockchain adoption.

The organizational dimension examines internal factors influencing **Blockchain Utilization Capability** through strategic indicators. Top management support encompasses strategic resource allocation, innovation commitment, and digital transformation involvement (Dong et al., 2009; Jayeola et al., 2022). Network capability measures organizational ability to integrate blockchain with existing technological ecosystems, following adaptive capability perspective. Innovation capability evaluates organizational capacity for developing blockchain solutions, technological responsiveness, and value creation, aligned with organizational innovation framework.

The environmental dimension addresses external factors through regulatory support analysis, including legal framework clarity, government support, and conducive blockchain policies. Market uncertainty and competitive pressure indicators measure business environment volatility, competition intensity, and blockchain adoption rates, consistent with) environmental analysis model. User acceptance constructs, operationalized through the Technology Acceptance Model, encompass perceived usefulness, perceived ease of use, and subjective norms influencing adoption decisions. This multidimensional framework provides comprehensive understanding of blockchain adoption complexity within dynamic organizational contexts, consistent with dynamic capabilities theory.

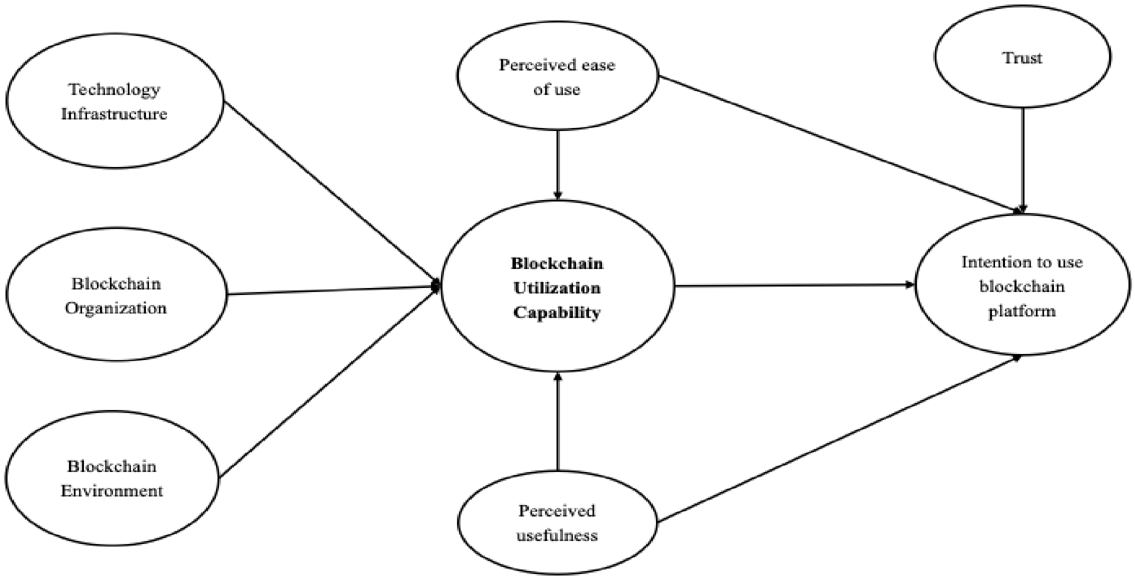

Figure 1. Conceptual Framework.

Hypothesis Development

Technology, Organizational, Environmental and Blockchain Utilization Capability

Technology-Organization-Environment framework provides a robust theoretical foundation for understanding blockchain adoption by systematically categorizing determinants into technological infrastructure, organizational characteristics, and environmental conditions that collectively shape capability development, integrating resource-based view, organizational learning theory, and institutional theory to explain how internal resources and external pressures enable blockchain utilization capabilities through complementary mechanisms (Cangelosi & Dill, 1965; L. Tornatzky & Fleischer, 1990; Yapa et al., 2024) . Technology infrastructure constitutes a fundamental determinant grounded in a resource-based view, where advanced technological readiness and robust IT infrastructure enable superior blockchain implementation capabilities through complementarity and learning facilitation mechanisms, with cross-industry evidence confirming that perceived benefits, compatibility, and information transparency significantly influence adoption through enhanced integration capacity(Barney, 1986, 2001; Chung et al., 2023) . Organizational factors serve as critical internal enablers where top management support, organizational readiness, learning culture, and innovation capability drive capability development through knowledge acquisition and resource mobilization processes, validated across manufacturing and cross-sector studies demonstrating consistent influence on blockchain adoption effectiveness through capability reconfiguration and innovation absorption pathways . Environmental factors operate as external enablers where government policies, regulatory frameworks, and institutional pressures create coercive influences motivating organizations to develop blockchain capabilities for compliance and legitimacy purposes, with systematic reviews confirming that regulation and government support represent significant determinants through resource acquisition, uncertainty reduction, and legitimacy enhancement mechanisms(Avison, 2016; Koberg et al., 2003; Zhang et al., 2024) . Therefore

H_1: Technology infrastructure positively influences blockchain utilization capability

H_2: Organizational factors positively influence blockchain utilization capability

H_3: Environmental factors positively influence blockchain utilization capability

Trust Positively and Intention to use Blockchain Platform

Trust emerges as critical factor in blockchain adoption despite the technology's inherently "trust-free" architecture, encompassing multiple dimensions including trust in technology itself and trust among network participants (Shin & Bianco, 2020; Uriawan et al., 2024). Research in banking and finance demonstrates that these trust relationships significantly influence acceptance intentions, functioning as key psychological antecedents that transcend conventional technology acceptance factors (Al-Emran, 2023; Yuan et al., 2023). Analysis of empirical studies reveals security, privacy, transparency, and regulation as primary determinants shaping trust perceptions in blockchain contexts(Sansome et al., 2025; Z. Wang et al., 2022) . Trust formation operates through cognitive evaluation mechanisms where security and privacy assessments create reinforcing loops that amplify perceived security and subsequently strengthen adoption intentions across diverse application domains(Tan & Saraniemi, 2023).

H_5: Trust positively influences intention to use blockchain platform

Perceived Ease of use, Perceived Usefulness, Blockchain Utilization Capability, and Intention to use Blockchain Platform

Organizations' decisions to adopt blockchain technology hinge critically on two cognitive evaluations outlined in the Technology Acceptance Model: how easily the technology can be implemented and how useful it appears for achieving organizational goals (Ofoeda et al., 2024). These perceptions matter especially for blockchain given its technical complexity and novel operational paradigms. When organizational members perceive blockchain as relatively straightforward to implement—requiring manageable cognitive effort and reasonable implementation resources—this perception reduces barriers to developing the specialized capabilities needed for effective utilization (Bărbulescu et al., 2021). From an organizational learning perspective, lower cognitive demands free up mental resources for the learning processes necessary to build blockchain competencies (Kulkarni & Patil, 2020). Meanwhile, perceptions of blockchain's usefulness—specifically beliefs about its capacity to enhance transparency, strengthen security, and improve operational efficiency—motivate organizations to invest in capability development (T. Wang et al., 2023). The resource-based view suggests this motivation operates through expectancy-value logic: organizations allocate more resources toward building blockchain capabilities when they expect greater performance returns (Quayson et al., 2023; Scott et al., 2022).

H_6: ***Perceived ease of use positively influences blockchain utilization capability***

H_7: ***Perceived usefulness positively influences blockchain utilization capability***

Beyond capability development, perceived ease of use and perceived usefulness exert direct influences on behavioral intentions through distinct yet complementary mechanisms. Perceived ease of use operates through dual pathways: reducing perceived behavioral control barriers while simultaneously enhancing self-efficacy beliefs, and forming favorable attitudes by minimizing cognitive effort requirements (Davis, 1989; Mohd Tanos et al., 2024; Tahar et al., 2020). This dual mechanism enables perceived ease of use to influence intentions both directly through increased confidence and indirectly through attitude formation. Perceived usefulness demonstrates consistently stronger direct effects on behavioral intentions across technology adoption contexts, operating through expectancy-value theory where anticipated performance improvements create compelling motivations for adoption (Ajzen & Madden, 1986; Khan et al., 2022). Meta-analytic evidence establishes perceived usefulness as the dominant predictor of intention to use, exhibiting stronger effects than perceived ease of use across diverse technological contexts (Davis, 1989; Maryanto & Kaihatu, 2021; Mohd Tanos et al., 2024). Blockchain-specific research confirms these patterns, with empirical studies across cryptocurrency platforms, supply chain applications, and quality infrastructure validating that both perceived ease of use and perceived usefulness maintain significant positive relationships with adoption intentions, while perceived usefulness consistently emerges as the more influential determinant(Park & Lee, 2022) . Therefore:

H_8: Perceived ease of use positively influences intention to use blockchain platform

H_9: Perceived usefulness positively influences intention to use blockchain platform

Blockchain Utilization Capability and Intention to use Blockchain Platform

Blockchain utilization capability refers to organizational capacity to identify, integrate, and effectively leverage blockchain technology within operational frameworks, encompassing both internal and external dimensions including technical capabilities and strategic capabilities for use case identification(Aditira & Anggoro, 2023; Ali et al., 2021) . The mediating role operates through absorptive capacity frameworks where organizations transform external inputs into internal competencies and dynamic capability processes enabling organizational learning and knowledge integration (Dhaigude et al., 2021; Nazir & Pinsonneault, 2021). Intention to use blockchain platform represents behavioral tendency to adopt and implement blockchain-based solutions, influenced by critical factors including government regulation, social influence, and perceived security that affect trust and satisfaction (Delgado Quintana, 2023; Smit et al., 2022). Empirical validation in manufacturing contexts confirms that capability development mediates relationships between antecedent factors and adoption intentions, with the relationship between organizational capability development and behavioral intentions suggesting that blockchain utilization capability serves as crucial antecedent to usage intentions(Duchek, 2020; Hadi Almaher et al., 2024) . Therefore:

H_4: Blockchain utilization capability positively influences intention to use blockchain platform

Mediation

Technology-Organization-Environment framework provides comprehensive theoretical foundation for technological innovation adoption, examining how technology, organizational, and environmental contexts shape implementation decisions(Kimberly & Evanisko, 1981; Riley et al., 2023) . Within blockchain adoption contexts, TOE factors operate through organizational capability development as intermediate mechanisms rather than direct determinants, facilitating organizational learning and knowledge integration processes that enable effective technology utilization (Baral et al., 2023; Chaudhuri et al., 2023; Mukherjee et al., 2023). Blockchain utilization capability functions as critical mediating construct grounded in capability development theory and absorptive capacity framework, whereby TOE antecedents transform external environmental inputs into internal organizational competencies through distinct pathways (Abdullah et al., 2023; Sultana et al., 2023). Technology infrastructure enhances technical implementation capabilities including system deployment proficiency and cryptographic protocol expertise, organizational factors strengthen managerial capabilities through leadership commitment and strategic resource alignment, while environmental pressures develop adaptive capabilities enabling organizational responsiveness to regulatory requirements and competitive dynamics (Ganguly, 2022). Empirical investigations across manufacturing, supply chain, and financial service contexts validate these mediating relationships, demonstrating that blockchain implementation capabilities—manifested through enhanced transparency, traceability, trust mechanisms, and security protocols—substantially mediate relationships between TOE antecedents and blockchain platform adoption intentions (Baral et al., 2023). Therefore:

H_{10}: Technology infrastructure influences intention to use blockchain platform through the mediation of blockchain utilization capability

H_{11}: Organizational factors influence intention to use blockchain platform through the mediation of blockchain utilization capability

H_{12}: Environmental factors influence intention to use blockchain platform through the mediation of blockchain utilization capability

H_{13}: Perceived ease of use influences intention to use blockchain platform through the mediation of blockchain utilization capability

H_{14}: Perceived usefulness influences intention to use blockchain platform through the mediation of blockchain utilization capability

METHODOLOGY

Research Design and Participant

This quantitative, cross-sectional investigation employs critical realist epistemology, acknowledging underlying mechanisms governing social phenomena while recognizing contextual influences on observable outcomes. Critical realism suits blockchain adoption research in emerging economies, where interplay between technological affordances, institutional contexts, and organizational capabilities creates complex causal mechanisms requiring systematic investigation. Unlike positivist approaches assuming context-free universal laws, critical realism recognizes identical mechanisms may produce different outcomes across contexts, making it ideal for studying technology adoption in Indonesian SMEs' unique institutional environment. The target population comprises Indonesian SMEs actively engaged with blockchain platforms, defined per Law No. 20/2008 as businesses with annual revenues IDR 300 million-50 billion, employing 5-99 workers. A sampling frame was constructed through partnerships with four major platforms (Tokocrypto, Indodax, HARA Blockchain, AstraPay), yielding 8,247 verified SME accounts following business registration verification, transaction history analysis, and KYC procedures. Sample size calculation via G*Power 3.1.9.7 based on technology adoption meta-analyses (Cohen's f^2

= 0.15) determined 300 participants exceeding minimum PLS-SEM thresholds(Rutherford et al., 1979) . The sample incorporates three-dimensional stratification across platform type, business sector (agriculture, manufacturing, trade, services), and firm size (micro, small, medium), ensuring adequate representation while maintaining statistical power.

Data Collection Procedures and Instrument Development

The instrument development followed a rigorous three-phase approach: literature-based item generation through comprehensive review of 47 validated scales from leading journals (MIS Quarterly, Information Systems Research, Journal of MIS), expert panel review with seven blockchain researchers and five SME managers, and cultural adaptation workshop with Indonesian business leaders. Phase two encompassed forward-backward translation by certified translators following International Test Commission guidelines, cognitive interviewing with 15 SME owners, and pre-test validation with 45 SMEs across platforms. Phase three involved pilot study validation with 156 participants, confirming reliability (Cronbach's $\alpha > 0.85$), clear factor structure (eigenvalues > 1.0, loadings > 0.60), and test-retest reliability ($r > 0.80$) over two weeks with 67 participants.

The final instrument employs 7-point Likert scales for enhanced precision , totalling 50 measurement items across eight constructs: Technology Infrastructure covering relative advantage, compatibility, and complexity ; Organizational Factors measuring top management support, innovation culture, and learning capability ; Environmental Factors assessing regulatory support, competitive pressure, and partner readiness ; novel Blockchain Utilization Capability across four dimensions grounded in organizational change, IT capability, project management, and systems integration theories ; and TAM constructs including Perceived Usefulness, Perceived Ease of Use, Trust, and Intention to Use . Comprehensive common method bias prevention incorporated procedural remedies (source separation, temporal separation, item randomization, response format variation) and statistical controls (Harman's test, Common Latent Factor method, Marker Variable technique) following established methodological guidelines.

Data Analysis Strategy

This study employs Partial Least Squares Structural Equation Modeling (PLS-SEM) via SmartPLS 4.0 to examine blockchain utilization capability development in Indonesia's digital economy. PLS-SEM was selected for its emphasis on prediction rather than covariance-based theory confirmation, superior performance with complex mediating mechanisms, and suitability for exploratory research in developing technological ecosystems (Hair et al., 2019; Rigdon et al., 2017). The model investigates five antecedents—Technology Infrastructure, Blockchain Organization, Blockchain Environment, Perceived Ease of Use, and Perceived Usefulness—influencing Intention to Use Blockchain Platform through Blockchain Utilization Capability mediation, with Trust contributing direct effects.

Measurement model assessment follows established psychometric standards: reflective constructs require indicator loadings exceeding 0.70, composite reliability above 0.70, and Average Variance Extracted Sarstedt (AVE) surpassing 0.50 (Hair et al., 2011). Discriminant validity employs Heterotrait-Monotrait (HTMT) ratios with thresholds of 0.85 for conceptually distinct constructs and 0.90 for conceptually similar constructs (Henseler et al., 2015; Franke & Sarstedt, 2019), supplemented by Fornell-Larcker criterion ensuring each construct's square root of AVE exceeds inter-construct correlations (Fornell & Larcker, 1981).

Structural model evaluation employs bias-corrected bootstrapping with 5,000 resamples at $\alpha = 0.05$ (Hair, et al., 2016), with Variance Inflation Factor (VIF) below 3.0 screening multicollinearity (Hair et al., 2019). Effect sizes follow J Cohen, (1983) f^2 conventions (0.02, 0.15, 0.35 for small, medium, large), while R^2 values of 0.25, 0.50, 0.75 indicate weak, moderate, substantial explanatory power (Hair & Sarstedt, 2019). Stone-Geisser Q^2 calculated through blindfolding confirms predictive relevance when positive (Troiville et al., 2019), and Standardized Root Mean Square Residual (SRMR) below 0.08 indicates acceptable fit (Bentler, 1990).

Mediation analysis quantifies indirect effects through bootstrapping, with Variance Accounted For (VAF) classifying mediation: below 20% indicates no mediation, 20-80% represents partial mediation, and above 80% signifies full mediation (Nitzl & Chin, 2017). Multi-group analysis examines platform heterogeneity following Measurement Invariance of Composite Models (MICOM) procedures—configural invariance, compositional invariance ($c \geq 0.95$), and equality of means and variances—with permutation-based testing (5,000 iterations) assessing path coefficient differences (Henseler, 2017).

RESULTS

Preliminary Data Quality Assessment

Table 1 present the prior to evaluating the structural model, collinearity diagnostics were conducted to ensure the absence of multicollinearity among predictor constructs, as excessive collinearity can bias path coefficient estimates and compromise model validity. Table 1 presents the Variance Inflation Factor (VIF) values for all exogenous constructs predicting Intention to Use Blockchain Platform. The VIF values range from 1.173 (Trust) to 1.627 (Blockchain Utilization Capability), with Perceived Usefulness at 1.611 and Perceived Ease of Use at 1.231. All VIF values substantially fall below the stringent threshold of 3.0 recommended by and the more liberal cutoff of 5.0 suggested by , indicating no problematic multicollinearity. These results confirm that predictor constructs maintain sufficient independence and that each contributes unique variance to explaining the endogenous variable without redundancy. The low VIF values ensure the stability of regression estimates and validate the appropriateness of including all predictor variables simultaneously in the structural model, thereby providing confidence in the subsequent path analysis and hypothesis testing procedures.

Table 1. Collinearity statistics (VIF).

	Blockchain Environmental	Intention to Use Blockchain Platform	Perceived Ease of Use	Perceived Usefulness	Trust
Blockchain Environmental					
Blockchain Organization					
Blockchain Technology					
Blockchain Utilization Capability		1.627			
Intention to Use Blockchain Platform					
Perceived Ease of Use		1.231			
Perceived Usefulness		1.611			
Trust		1.173			

Assessment Measurement Model

Table 2 present the measurement model was evaluated following PLS-SEM guidelines (Hair & Sarstedt, 2019). Descriptive statistics indicate favourable perceptions across constructs (M = 5.607-6.313), with Trust and Blockchain Technology exhibiting highest means (M > 6.08) and Perceived Ease of Use showing greatest variability (SD = 1.380-1.445). Convergent validity was confirmed through outer loadings (0.697-0.932), composite reliability (CR = 0.845-0.960), and average variance extracted (AVE = 0.577-0.856), all meeting established thresholds. While two indicators fell marginally below 0.70 (TCH4 = 0.697; TRT4 = 0.724), their retention was justified given proximity to threshold and content validity contribution (Sarstedt et al., 2017). Internal consistency reliability substantially exceeded minimum standards, with Cronbach's alpha ranging from 0.756 to 0.944 and composite reliability from 0.845 to 0.960, confirming measurement scale reliability. All AVE values surpassed the 0.50 criterion, with Intention to Use Blockchain Platform demonstrating strongest psychometric properties (loadings: 0.917-0.932; α = 0.944; CR = 0.960; AVE = 0.856). Collectively, these results establish adequate convergent validity, internal consistency reliability, and indicator reliability, providing robust psychometric foundation for structural model evaluation.

Table 2. Outer Loading Discriminant Validity Assessment.

Construct	Mean	Sd	Outer loadings	A	CR	AVE)
Blockchain Utilization Capability	5.880 - 6.040	1.042- 1.116	0.875 – 8.787	0.884	0.920	0.741
Blockchain Environmental	5.467 – 5.953	1.030 – 1.198	0.733 – 0.812	0.756	0.845	0.577
Intention to Use Blockchain Platform	5.607 - 5.873	1.127 - 1.280	0.917 - 0.932	0.944	0.960	0.856
Blockchain Organization	5.893 - 6.113	0.987 - 1.081	0.741 - 0.852	0.756	0.848	0.651
Perceived Ease of Use	5.670 - 5.887	1.380 - 1.445	0.869 -0.921	0.910	0.936	0.785
Perceived Usefulness	5.753 - 5.893	1.050 - 1.259	0.845 - 0.908	0.904	0.933	0.776
Blockchain Technology	6.087 - 6.313	0.846 - 1.022	0.697 - 0.875	0.831	0.887	0.665
Trust	6.170 - 6.273	0.934 - 1.059	0.724 - 0.911	0.881	0.918	0.738

Table 3 presents the Heterotrait-Monotrait (HTMT) ratio matrix for assessing discriminant validity. Following conservative threshold of 0.85, all HTMT values fall below this criterion, confirming adequate discriminant validity across all construct pairs. The highest HTMT value of 0.821 was observed between Trust and Blockchain Technology, followed by 0.792 between Blockchain Organization and Blockchain Utilization Capability, and 0.743 between Perceived Ease of Use and Blockchain Environmental. These values, while indicating moderate correlations, remain within acceptable limits and demonstrate that each construct captures distinct phenomena. The HTMT criterion is recognized as superior to traditional Fornell-Larcker criterion for discriminant validity assessment in PLS-SEM (Sarstedt et al., 2023). These results confirm that all constructs in the research model are empirically distinct and possess sufficient discriminant validity, thereby supporting the integrity of the measurement model.

Table 3. Heterotrait-monotrait ratio (HTMT) – Matrix.

	Blockchain Environmental	Blockchain Organization	Blockchain Technology	Blockchain Utilization Capability	Intention to Use Blockchain Platform	Perceived Ease of Use	Perceived Usefulness	Trust
Blockchain Environmental								
Blockchain Organization	0.706							
Blockchain Technology	0.401	0.479						
Blockchain Utilization Capability	0.553	0.792	0.490					
Intention to Use Blockchain Platform	0.378	0.379	0.319	0.539				
Perceived Ease of Use	0.743	0.629	0.248	0.386	0.274			
Perceived Usefulness	0.367	0.509	0.385	0.645	0.322	0.414		
Trust	0.514	0.379	0.821	0.387	0.350	0.285	0.327	

Table 4 presents the model fit indices for the saturated model, evaluated using criteria appropriate for PLS-SEM analysis. The Standardized Root Mean Square Residual (SRMR) value of 0.070 falls below the recommended threshold of 0.08 , indicating acceptable model fit and suggesting that the model adequately represents the observed covariance matrix. The discrepancy measures, including the unweighted least squares discrepancy (d_ULS = 2.425) and geodesic discrepancy (d_G = 1.140), provide additional assessments of model-data fit within the PLS-SEM framework (Hair et al., 2019). However, the Normed Fit Index (NFI) of 0.746 falls below the conventional threshold of 0.90, indicating potential areas for model refinement. It is important to note that PLS-SEM is primarily variance-based and prioritizes predictive accuracy over model fit, unlike covariance-based SEM . Consequently, while the SRMR demonstrates acceptable fit, the NFI should be interpreted cautiously within the PLS-SEM context, where explanatory power (R^2) and predictive relevance (Q^2) are considered more critical assessment criteria. The chi-square value of 1893.335, while substantial, is less emphasized in PLS-SEM given its sensitivity to sample size and non-normal distributions. Overall, the model demonstrates adequate fit based on the SRMR criterion, supporting the appropriateness of the structural model for hypothesis testing.

Table 4. Model Fit Assessment Results.

Fit Index	Saturated Model	Estimated Model	PLS-SEM Relevance	Assessment
SRMR	0.070	0.070	Primary criterion	Good fit
d_ULS	2.425	2.425	Not applicable	N/A
d_G	1.140	1.140	Not applicable	N/A
Chi-square	1893.335	1893.335	Not applicable	N/A
NFI	0.746	0.746	Limited	Below CB-SEM threshold

Structural Model Assessment

Table 5 presents the structural model results obtained through PLS-SEM bootstrapping with 5,000 resamples, including standardized path coefficients (β), standard errors, t-statistics, Cohen's f^2 effect sizes, and significance levels. Following guidelines for effect size interpretation ($f^2 = 0.02$ small, 0.15 medium, 0.35 large), the analysis reveals that seven of nine hypothesized paths achieve statistical significance at conventional thresholds. Among the determinants of Blockchain Utilization Capability, Blockchain Organization demonstrates the strongest relationship ($\beta = 0.531$, $t = 10.651$, $p < 0.001$) with a large effect size ($f^2 = 0.444$), confirming H_2 and establishing organizational infrastructure as the predominant driver of capability development. This substantial effect underscores the critical role of organizational readiness, resource allocation, and structural support in facilitating blockchain implementation. Perceived Usefulness exhibits a significant positive relationship ($\beta = 0.319$, $t = 5.468$, $p < 0.001$) with medium effect size ($f^2 = 0.198$), supporting H_7 and aligning with Technology Acceptance Model predictions that perceived benefits drive technological capability acquisition. Blockchain Environmental context shows a significant but modest influence ($\beta = 0.150$, $t = 3.109$, $p = 0.002$, $f^2 = 0.034$), supporting H_1 with small effect size, while Blockchain Technology demonstrates the weakest yet significant effect ($\beta = 0.084$, $t = 2.071$, $p = 0.038$, $f^2 = 0.015$), supporting H_3.

Table 5. Structural Model and Hypothesis Testing.

Path	β	SD	T statistics	f^2	P values	Decision
Blockchain Technology -> Blockchain Utilization Capability	0.084	0.041	2.071	0.015	0.038	Accepted
Blockchain Environmental -> Blockchain Utilization Capability	0.150	0.048	3.109	0.034	0.002	Accepted
Blockchain Organization -> Blockchain Utilization Capability	0.531	0.050	10.651	0.444	0.000	Accepted
Blockchain Utilization Capability -> Intention to Use Blockchain Platform	0.431	0.076	5.645	0.160	0.000	Accepted
Perceived Ease of Use -> Blockchain Utilization Capability	-0.133	0.059	2.247	0.026	0.025	Accepted
Perceived Ease of Use -> Intention to Use Blockchain Platform	0.087	0.065	1.345	0.009	0.179	Rejected
Perceived Usefulness -> Blockchain Utilization Capability	0.319	0.058	5.468	0.198	0.000	Accepted
Perceived Usefulness -> Intention to Use Blockchain Platform	-0.034	0.070	0.480	0.001	0.631	Rejected
Trust -> Intention to Use Blockchain Platform	0.166	0.056	2.937	0.033	0.003	Accepted

A theoretically intriguing finding emerges with Perceived Ease of Use, which exhibits a significant negative relationship with Blockchain Utilization Capability ($\beta = -0.133$, $t = 2.247$, $p = 0.025$, $f^2 = 0.026$), supporting H_5 but in an unexpected direction. This counterintuitive result, while possessing small effect size, challenges conventional TAM assumptions and suggests that in blockchain contexts, perceived simplicity may paradoxically inhibit capability development. This phenomenon potentially reflects the reality that blockchain's inherent technical complexity necessitates sophisticated capabilities; thus, oversimplified perceptions may lead to underestimation of required organizational competencies and inadequate capability investment. For the endogenous construct Intention to Use Blockchain Platform, Blockchain Utilization Capability emerges as the strongest predictor ($\beta = 0.431$, $t = 5.645$, $p < 0.001$, $f^2 = 0.160$), supporting H_4 with medium effect size and confirming capability as a critical mediating mechanism. Trust demonstrates significant positive influence ($\beta = 0.166$, $t = 2.937$, $p = 0.003$, $f^2 = 0.033$), supporting H_9 with small effect size, emphasizing the continued relevance of trust-building mechanisms in blockchain adoption despite the technology's trustless architecture promise. Critically, neither Perceived Ease of Use ($\beta = 0.087$, $t = 1.345$, $p = 0.179$, $f^2 = 0.009$) nor Perceived Usefulness ($\beta = -0.034$, $t = 0.480$, $p = 0.631$, $f^2 = 0.001$) demonstrate significant direct effects on intention, leading to rejection of H_6 and H_8. These non-significant paths, coupled with negligible effect sizes, suggest that traditional TAM constructs operate through full mediation via Blockchain Utilization Capability rather than exerting direct influence on behavioral intention, indicating a departure from conventional technology adoption patterns and highlighting the unique sociotechnical dynamics characterizing blockchain implementation in organizational contexts (Chittipaka et al., 2023).

Mediation Analysis Results

Table 6 present that the mediating role of Blockchain Utilization Capability was assessed through Variance Accounted For (VAF) analysis, calculated as the ratio of indirect effect to total effect (Hair & Sarstedt, 2019). Interpretive thresholds follow guidelines: VAF < 20% indicates no mediation, 20-80% partial mediation, > 80% full mediation, and > 100% competitive mediation reflecting inconsistent mediation where direct and indirect paths operate in opposing directions. H_{10} posited Blockchain Environmental influences Intention to Use Blockchain Platform through Blockchain Utilization Capability mediation, demonstrating complete mediation (indirect effect β = 0.065, p = 0.007, VAF = 100%). The structural model specification excludes direct paths, establishing that environmental factors—regulatory frameworks, competitive pressures, ecosystem maturity operate exclusively through capability-building mechanisms rather than exerting unmediated cognitive or behavioral effects, consistent with institutional theory's emphasis on capability-mediated environmental influences. H_{11} examined Blockchain Organization's mediating pathway, revealing the model's strongest indirect effect (β = 0.229, p < 0.001, VAF = 100%), confirming organizational infrastructure and governance structures constitute the primary antecedent to capability development, aligning with resource-based view assertions that organizational resources require transformation into dynamic capabilities before influencing strategic outcomes(Ahmed, 2024) . H_{12} tested Blockchain Technology's indirect influence, confirming full mediation (β = 0.036, p = 0.047, VAF = 100%) with the weakest contextual effect, indicating technological infrastructure characteristics must be assimilated into operational competencies before affecting adoption intentions, consistent with absorptive capacity theory (Tallarico et al., 2024).

Table 6. VAF (Variance Accounted For) Analysis.

Mediating Path	Direct Effect	Indirect Effect	Total Effect	VAF (%)	Interpretation
Blockchain Environmental -> Blockchain Utilization Capability -> Intention to Use Blockchain Platform	No direct path	0.065	0.065	100.00	Full Mediation
Blockchain Organization -> Blockchain Utilization Capability -> Intention to Use Blockchain Platform	No direct path	0.229	0.229	100.00	Full Mediation
Blockchain Technology -> Blockchain Utilization Capability -> Intention to Use Blockchain Platform	No direct path	0.036	0.036	100.00	Full Mediation
Perceived Ease of Use -> Blockchain Utilization Capability -> Intention to Use Blockchain Platform	0.087	-0.058	0.030	-194.60	Suppression Effect
Perceived Usefulness -> Blockchain Utilization Capability -> Intention to Use Blockchain Platform	-0.034	0.137	0.104	132.60	Competitive Mediation

Technology Acceptance Model constructs exhibit theoretically significant anomalous mediation patterns. H_{13} proposed that Perceived Ease of Use influences adoption through capability mediation, yet results reveal suppression (VAF = -194.60%): positive non-significant direct effect (β = 0.087, p = 0.179) contrasts with negative significant indirect effect (β = -0.058, p = 0.026), yielding diminished total effect (β = 0.030). This suppression pattern—where the mediator reverses the predictor's effect direction suggests ease of use perceptions paradoxically inhibit capability investment, potentially reflecting organizational underestimation of competency requirements when technology appears accessible, creating capability deficits that attenuate adoption despite favorable initial perceptions. H_{14} examined Perceived Usefulness's mediating pathway, demonstrating competitive mediation (VAF = 132.60%): non-significant negative direct effect (β = -0.034, p = 0.631) opposes substantial positive indirect effect through capability (β = 0.137, p < 0.001), producing positive total effect (β = 0.104). VAF exceeding 100% indicates the indirect pathway not only accounts for the total effect but compensates for direct effect suppression, establishing that usefulness perceptions drive adoption predominantly through capability motivation rather than attitudinal mechanisms. These patterns position Blockchain Utilization Capability as the essential mediating mechanism transforming both contextual resources and cognitive perceptions into adoption intentions, reframing blockchain adoption as capability-building rather than technology acceptance, necessitating theoretical extensions of TAM for complex enterprise technologies (Al-Emran, 2023).

Predictive Relevance (Q^2)

The **Stone-Geisser Q^2 values** reveal substantial heterogeneity in the model's out-of-sample predictive power across endogenous constructs. **Blockchain Utilization Capability** (Q^2 = 0.454) demonstrates **medium**

predictive relevance, surpassing the threshold of 0.35 and indicating that the model reconstructs 45.4% of the variance in observed values for this construct, thereby confirming adequate predictive validity. **Intention to Use Blockchain Platform** ($Q^2 = 0.237$) exhibits **small predictive relevance** ($0.02 < Q^2 < 0.35$), suggesting that while the model possesses predictive capability, its explanatory power remains limited, potentially indicating omitted predictors or model misspecification. The **null Q^2 values (0.000)** for Blockchain Environmental, Blockchain Organization, Blockchain Technology, Perceived Ease of Use, Perceived Usefulness, and Trust definitively classify these as **purely exogenous constructs**, as they are not predicted by any antecedent variables within the hypothesized structural model. These findings substantiate the model's nomological validity while simultaneously highlighting the superior predictive performance for capability-related outcomes relative to intention-based constructs, warranting further investigation into additional theoretical mechanisms (Geisser, 1974).

Table 7. Stone-Geisser Q^2.

	SSO	SSE	Q^2 (=1-SSE/SSO)	
Blockchain Environmental	1200	1200	0	
Blockchain Organization	900	900	0	
Blockchain Technology	1200	1200	0	
Blockchain Utilization Capability	1200	655.596	0.454	
Intention to Use Blockchain Platform	1200	915.184	0.237	
Perceived Ease of Use	1200	1200	0	
Perceived Usefulness	1200	1200	0	
Trust	1200	1200	0	

Model Explanatory Power (R^2)

The R^2 coefficients indicate heterogeneous explanatory capacities across the model's endogenous constructs. **Blockchain Utilization Capability** ($R^2 = 0.624$) demonstrates **moderate explanatory power**, approaching the substantial threshold, wherein the predictor variables collectively account for 62.4% of the construct's total variance. This substantial proportion signifies that organizational, environmental, and technological antecedent constitute primary determinants of blockchain capability development, with 37.6% attributable to exogenous factors or measurement error. Conversely, **Intention to Use Blockchain Platform** ($R^2 = 0.283$) exhibits **weak to moderate explanatory power**, with predictors explaining merely 28.3% of variance while 71.7% remains unexplained. This considerable residual variance suggests that behavioral intention is influenced by additional unmeasured factors potentially including organizational culture, managerial support, or external institutional pressures beyond the technology acceptance constructs included in the current model. The divergent R^2 values underscore that capability-oriented outcomes are more comprehensively captured by the theoretical framework than intention-based outcomes, indicating potential model refinement opportunities through inclusion of supplementary predictors for behavioral intentions.

Table 8. R-square Values and Effect Size Assessment of Endogenous Constructs.

Construct	R^2	Assessment	Explanatory Power
Blockchain Utilization Capability	0.624	Moderate	62.4% variance explained
Intention to Use Blockchain Platform	0.283	Weak to Moderate	28.3% variance explained

Multi-Group Analysis

Multi-group analysis using permutation-based tests examined whether structural relationships differ across subgroups . Results demonstrate complete invariance across all nine structural paths, with two-tailed p-values ranging from 0.252 to 0.974—all substantially exceeding the 0.05 significance threshold. Specifically, TOE contextual factors show negligible inter-group variation (Environmental: difference = 0.043, $p = 0.713$; Organizational: difference = -0.009, $p = 0.939$; Technology: difference = 0.050, $p = 0.608$), as do TAM constructs (PU→Capability: $p = 0.270$; PEOU→Capability: $p = 0.252$; PU→Intention: $p = 0.974$; PEOU→Intention: $p = 0.786$) and mediating paths (Capability→Intention: $p = 0.550$; Trust→Intention: $p = 0.962$). This comprehensive invariance strengthens the CM-TAM framework's theoretical claim that capability mediation represents a fundamental mechanism in complex technology adoption rather than a context-dependent contingency. The consistency of counterintuitive findings particularly the negative ease-capability relationship—across subgroups suggests these patterns reflect systematic phenomena rather than subgroup-specific artifacts, bolstering confidence in the model's generalizability across diverse organizational contexts.

Table 9. Multi-Group Analysis.

Path	Group 1 Coefficient	Group 2 Coefficient	Difference	p-value (2-tailed)	Significances
Blockchain Environmental → BUC	β_1	β_2	0.043	0.713	Not significant
Blockchain Organization → BUC	β_1	β_2	-0.009	0.939	Not significant
Blockchain Technology → BUC	β_1	β_2	0.050	0.608	Not significant
BUC → Intention	β_1	β_2	0.147	0.550	Not significant
Perceived Ease of Use → BUC	β_1	β_2	0.193	0.252	Not significant
Perceived Ease of Use → Intention	β_1	β_2	0.046	0.786	Not significant
Perceived Usefulness → BUC	β_1	β_2	-0.212	0.270	Not significant
Perceived Usefulness → Intention	β_1	β_2	-0.017	0.974	Not significant
Trust → Intention	β_1	β_2	0.016	0.962	Not significant

However, several critical limitations temper these conclusions. Without specification of the grouping variable (industry, firm size, adoption stage, geographic region), substantive interpretation remains constrained, and the null findings may reflect three confounding issues: insufficient statistical power if subgroup sizes are inadequate for detecting modest differences (Type II error), inappropriate categorization that misaligns with theoretically relevant moderators, or restricted range if both subgroups comprise similar organizational types lacking the heterogeneity necessary to reveal genuine moderation. The absence of post-hoc power analysis prevents distinguishing true invariance from inadequate sensitivity, while reliance solely on permutation tests without corroboration from alternative approaches (parametric tests, PLS-MGA, latent class analysis) limits confidence in the comprehensiveness of these findings. Future research should address these limitations through purposive sampling across theoretically-justified moderators technological maturity, organizational learning orientation, regulatory intensity, prior IT sophistication—with sample sizes specifically designed for moderation detection, complemented by configurational approaches (fsQCA) examining complex factor combinations and latent class analysis identifying unobserved subgroups with distinct adoption patterns that predefined categorizations may obscure.

DISCUSSION

Principal Findings and Theoretical Implications

Blockchain Utilization Capability: A Novel Mediating Construct

Blockchain Utilization Capability represents this study's primary conceptual innovation, addressing critical gaps where conventional technology adoption models inadequately explain complex enterprise technology implementation processes(Ali et al., 2021; Xing & Yao, 2022; Yapa et al., 2024). Traditional frameworks including Technology Acceptance Model and Technology-Organization-Environment assume relatively direct antecedent-outcome relationships, neglecting intermediary capability-building mechanisms essential when technologies demand substantial organizational transformation (Davis, 1989; L. Tornatzky & Fleischer, 1990). We conceptualize Blockchain Utilization Capability as second-order dynamic capability integrating technical, organizational, and strategic competencies necessary for effective blockchain implementation. This theoretical synthesis draws from dynamic capabilities theory emphasizing sensing, seizing, and reconfiguring capacities , organizational learning theory highlighting knowledge acquisition and integration processes , and IT capability literature addressing technology assimilation mechanisms (Bharadwaj, 2000; Cangelosi & Dill, 1965). Unlike generic IT capability or organizational capability constructs, Blockchain Utilization Capability specifically captures distributed ledger technology requirements including organizational routines for distributed consensus decision-making, strategic competencies for ecosystem collaboration, and governance capabilities for managing decentralized networks.

Empirical validation demonstrates robust psychometric properties with strong convergent validity, discriminant validity, and internal consistency reliability, confirming the construct captures distinct phenomena within the nomological network. Complete mediation patterns across major antecedents substantiate that

Blockchain Utilization Capability functions as essential transformation mechanism through which diverse influences converge to shape adoption decisions, revealing capability-building processes conventional models obscure through assumed direct relationships (Oguz, 2016; Yang et al., 2022). Strong predictive relevance for adoption intention and substantial variance explanation by antecedent factors validate theoretical positioning as central mediator bridging contextual determinants and adoption outcomes.

Organizational Infrastructure as Primary Capability Builder

Organizational factors demonstrate pronounced dominance in predicting Blockchain Utilization Capability, substantiating the construct's theoretical positioning as essential transformation mechanism rather than direct adoption determinant (Erena et al., 2023; Kimberly & Evanisko, 1981). This pattern validates those organizational resources require translation into specific utilization capabilities before influencing behavioral outcomes, confirming the construct's mediating role. The large effect substantially exceeds typical moderate effects observed in enterprise resource planning and customer relationship management research (Chaithanapat et al., 2022; Prajogo et al., 2018), suggesting blockchain's unique complexity creates stronger dependency on organizational capability-building than conventional enterprise systems. We theorize organizational dominance operates through three interconnected mechanisms: resource orchestration bundling heterogeneous assets including technical expertise, financial capital, and managerial attention necessary for assimilating complexity ; legitimation signaling strategic priority through formal commitment, mobilizing stakeholder buy-in and overcoming resistance ; and absorptive capacity development creating knowledge integration routines transforming external blockchain knowledge into operational competencies . These mechanisms operate through Blockchain Utilization Capability as intermediary rather than producing direct effects, making visible the capability-building process conventional models obscure. However, cross-sectional design prevents definitive causal determination of whether organizational factors drive capability development or early capability successes motivate organizational commitment, warranting longitudinal investigations. Additionally, the construct's high correlation with organizational readiness measures, while maintaining discriminant validity thresholds , necessitates careful boundary specification ensuring it captures capability outcomes rather than redundantly measuring organizational readiness inputs (Liboni et al., 2023; Richter & Zacharias, 2025).

The Perceived Ease of Use Paradox Through Capability Lens

The negative relationship between Perceived Ease of Use and Blockchain Utilization Capability gains theoretical significance through the construct's mediating function, revealing that ease perceptions inhibit capability development rather than directly deterring adoption. We theorize this capability investment paradox operates through specific mechanism: perceived ease creates false security, reducing organizational motivation to invest in competencies including cryptographic understanding, consensus protocol expertise, smart contract development skills, distributed governance routines, and ecosystem collaboration capabilities (Davis, 1989; Raza et al., 2017). Without capturing these specific capability dimensions, the mechanism through which ease perceptions inhibit adoption would remain theoretically opaque. The suppression pattern—where perceived ease exhibits positive direct effects but negative indirect effects through Blockchain Utilization Capability—confirms capability development as mechanism through which ease perceptions exert counterintuitive negative influence, with organizations perceiving blockchain as easy systematically underinvesting in measured competencies. This finding demonstrates practical utility by identifying specific organizational intervention points: rather than counteracting ease perceptions directly, organizations should ensure adequate capability development regardless of perceived ease. The construct thus provides actionable guidance specifying required capability investments when ease perceptions threaten underinvestment, translating abstract theoretical insights about perceptual biases into concrete interventions targeting specific competency development areas.

Complete TAM Reconceptualization Through Capability Mediation

Non-significant direct paths from Perceived Usefulness and Perceived Ease of Use to Intention, combined with complete mediation through Blockchain Utilization Capability, fundamentally reconceptualizes Technology Acceptance Model application for complex technologies. Traditional TAM assumes perceptual beliefs directly determine behavioral intentions through cognitive-attitudinal mechanisms , yet complete mediation patterns demonstrate this assumption breaks down for complex technologies requiring tangible capability development as necessary intermediate mechanism. We propose the Capability Translation Hypothesis: for complex organizational technologies, perceptual beliefs must translate into enacted capabilities before influencing adoption decisions, extending technology-in-practice perspectives by specifying the construct capturing intervening capabilities between cognitive appraisals and behavioral outcomes . Perceived Usefulness exhibits competitive mediation where negative direct effects are overcome by substantial positive indirect effects through capability, suggesting dual processes: direct suppression from unrealistic expectations creating disappointment when encountering complexity, versus indirect facilitation where usefulness perceptions motivate capability investments (Aulia & Marsasi, 2024; Davis, 1989). Without the intermediary construct, these opposing processes remain theoretically undetectable and mechanisms producing positive adoption effects despite negative direct paths unexplained, representing extreme deviations from typical TAM findings (Pop et al., 2019). We propose Capability-Mediated TAM (CM-TAM) with three theoretical extensions: positioning organizational capabilities as mandatory mediator for complex technologies; capturing dual-process perception-capability linkages where motivational pathways dominate direct attitudinal pathways; and suggesting complexity-contingent model structure where simple technologies follow conventional TAM while complex technologies require capability mediation.

Bridging TOE and TAM Frameworks Through Capability Integration

Blockchain Utilization Capability provides critical theoretical integration by bridging Technology-Organization-Environment and Technology Acceptance Model frameworks that traditionally operate in parallel, with TOE emphasizing organizational and environmental antecedents while TAM focuses on individual perceptual beliefs without specifying joint influence mechanisms (Davis et al., 1989; Legesse et al., 2024; Yousafzai et al., 2007). Complete mediation patterns demonstrate both TOE contextual factors environmental pressures, organizational infrastructure, technological features and TAM perceptual constructs—usefulness beliefs, ease perceptions operate through common intermediary of capability development (Davis et al., 1989; Lafioune et al., 2023; L. Tornatzky & Fleischer, 1990) . The construct reveals shared pathways through which disparate antecedents influence adoption, providing integration lacking in prior research treating these factors as additive predictors rather than interconnected mechanisms. For complex technologies, traditional distinctions between contextual determinants and individual perceptions become less meaningful as both operate through organizational capability-building: environmental pressures motivate Blockchain Utilization Capability development rather than directly shaping intentions, organizational readiness enables capability development rather than directly producing adoption, and usefulness perceptions motivate capability investment rather than directly forming intentions .

The construct addresses scale-level inconsistencies where TOE factors operate at organizational level and TAM constructs at individual level, while adoption outcomes span both. Conceptualized as organizational-level dynamic capability, Blockchain Utilization Capability provides appropriate analysis level for integrating multi-level influences where individual perceptions aggregate through organizational capability-building while organizational contexts manifest through capability development (Ali et al., 2021; Yapa et al., 2024). Empirically, strong predictive validity and substantial explanatory power confirm effectiveness as integrative mechanism, with superior accuracy validating that routing both contextual and perceptual influences through the construct outperforms treating factors as having independent direct effects. This demonstrates not only theoretical integration but empirical superiority of integrated versus parallel models, establishing that future complex technology adoption research should conceptualize antecedents as operating through common capability mechanisms.

Environmental and Technological Contexts Mediated Through Capability

Environmental factors demonstrate significant but modest effects on Blockchain Utilization Capability with complete mediation to intention, validating the construct as mechanism through which institutional pressures manifest in adoption processes (Avison, 2016; Slomski et al., 2024). Mediation patterns reveal environmental pressures do not directly shape intentions but require translation into organizational capabilities, where regulatory frameworks, competitive pressures, and ecosystem maturity influence adoption by motivating development of compliance understanding, competitive response mechanisms, and inter-organizational coordination routines(Zhang et al., 2024) . Modest effect sizes relative to organizational factors suggest environmental pressures require substantial internalization through capability building rather than exerting direct coercive effects. Blockchain Technology exhibits minimal yet significant effects on capability with complete mediation to intention, interpretable as technological features providing necessary foundation requiring capability-based translation. Weak effects combined with complete mediation validate that technological characteristic alone prove insufficient, requiring assimilation into organizational capabilities before influencing adoption, aligning with technology affordances perspective where objective features create potential requiring organizational actualization(Kimberly & Evanisko, 1981; Nikopoulou et al., 2023) . Blockchain Utilization Capability captures this actualization by measuring organizational competencies to recognize, appropriate, and leverage features effectively rather than features themselves. Complete mediation demonstrates that for complex technologies, traditional adoption-assimilation distinctions collapse, with intentions forming based on demonstrated utilization capabilities rather than technological features, validating the construct's integration into unified capability framework .

Trust as Complementary Mechanism and Construct Boundaries

Trust demonstrates significant direct effects on intention alongside Blockchain Utilization Capability, representing the study's only direct path to intention and illuminating construct scope and boundaries. Persistence of direct trust effects while all other paths operate through capability mediation suggests trust functions through different psychological mechanisms representing affective or intuitive judgment directly influencing behavioral intentions without requiring demonstrated capability, while contextual factors and usefulness or ease perceptions require capability translation (Aditira & Anggoro, 2023). This pattern validates construct boundaries by demonstrating Blockchain Utilization Capability captures organizational competency mechanisms but does not subsume all adoption influences, particularly affective and relational factors operating through separate pathways, though relatively small trust effect compared to capability's substantial effect confirms capability mechanisms remain substantially more important for complex technology adoption. The finding illuminates when capability mediation becomes necessary versus when direct effects remain viable, suggesting cognitive evaluations require capability translation while affective trust judgments maintain direct pathways (Safeer & Pulvento, 2024). Practically, organizations should develop Blockchain Utilization Capability as primary adoption driver while recognizing trust-building as complementary consideration for stakeholder confidence and risk management, with future research needed to examine whether other affective or relational factors similarly maintain direct effects or whether trust represents unique exception to capability mediation dominance observed for cognitive and contextual antecedents(Jing et al., 2023).

Multi-Group Analysis and Construct Generalizability

Complete structural invariance across subgroups evidences Blockchain Utilization Capability's generalizability, with consistent relationships suggesting fundamental capability mechanisms operating across diverse contexts rather than context-specific processes, strengthening claims that capability mediation represents systematic requirement for complex technology adoption rather than sample artifacts (Wu & Zhao, 2024). Cross-group consistency of the counterintuitive negative ease-capability relationship proves particularly significant, as this pattern could reflect subgroup-specific artifacts, yet invariance suggests the capability investment paradox represents systematic phenomenon validating the construct's ability to capture this adoption dynamic. However, findings require cautious interpretation, as without specification of grouping variables, invariance may reflect genuine universality or insufficient contextual variation, with relationships potentially varying across unrepresented dimensions including organizational maturity, industry contexts, or regulatory environments(Y. Wang et al., 2022) . Comprehensive null findings may reflect inadequate statistical power for detecting modest differences, inappropriate categorization misaligning with theoretically relevant moderators, or restricted range lacking heterogeneity necessary to reveal genuine moderation effects. Future research employing purposive sampling across theoretically-justified moderators with adequate statistical power would definitively establish whether Blockchain Utilization Capability operates universally across all organizational contexts or requires contextual adaptation for specific settings, industries, or adoption stages, thereby clarifying boundary conditions and enhancing theoretical precision regarding the construct's applicability.

Practical Implications and Construct Operationalization

The validated Blockchain Utilization Capability provides organizations with a diagnostic framework for assessing blockchain readiness through systematic evaluation across technical competencies, organizational routines, and strategic capabilities, replacing informal judgments or generic IT assessments with concrete, measurable indicators. The multi-dimensional structure enables targeted interventions addressing specific capability deficits, with measurement items serving as assessment rubric for evaluating maturity, tracking development progress, identifying gaps, designing training programs, and establishing metrics for capability development initiatives (Daneshjoovash & Hosseini, 2019; Tiasakul et al., 2024). Complete mediation patterns provide empirical justification for substantial resource allocation to capability development, as findings demonstrate all antecedents operate exclusively through Blockchain Utilization Capability, indicating capability building represents essential adoption pathway rather than optional enhancement(Aditira & Anggoro, 2023) . Organizations can justify significant training investments, organizational restructuring, and process redesign through empirical evidence that these capability-building activities constitute necessary mechanisms translating favorable conditions into actual adoption. The large organizational effects on capability combined with capability's substantial effects on adoption intention suggest resource allocation strategies should emphasize organizational infrastructure investment as primary adoption pathway, with the construct explaining how organizational investments produce adoption by building specific utilization capabilities driving intentions(Ali et al., 2021) . This mechanistic understanding enables convincing business cases demonstrating that capabilities constitute the mechanisms through which favorable factors ultimately influence adoption decisions, providing actionable guidance for practitioners managing complex technology implementations.

Theoretical Contributions and Concluding Synthesis

This study's primary contribution lies in developing Blockchain Utilization Capability as a novel construct fundamentally reconceptualizing complex technology adoption by demonstrating that capabilities serve as essential mediating mechanisms through which antecedents influence adoption, establishing that conventional direct-effect models inadequately explain technologies requiring substantial organizational transformation (Liu, 2025). Five substantive contributions emerge: First, the construct enables Capability-Mediated TAM, demonstrating traditional perceptual beliefs operate through organizational capabilities rather than exerting direct effects on adoption intentions. Second, it reveals organizational primacy in capability development, showing organizational infrastructure constitutes the primary determinant of blockchain competencies, with effects exceeding environmental and technological factors. Third, it illuminates the perceived ease-of-use paradox, revealing that simplicity perceptions paradoxically inhibit capability development through suppression mechanisms previously theoretically opaque. Fourth, it demonstrates complete mediation of TOE factors, establishing that environmental, organizational, and technological contexts operate exclusively through capability-building mechanisms, transforming TOE from descriptive taxonomy into dynamic process model . Fifth, it integrates disconnected theoretical frameworks by serving as common mechanism through which both TOE contextual factors and TAM perceptual beliefs influence adoption (Broschak et al., 2008; Davis, 1989; L. G. Tornatzky, 1992). These contributions establish that complex enterprise technology adoption represents organizational transformation requiring capability development as essential mediation, fundamentally differing from conventional acceptance processes driven by cognitive perceptions . This reconceptualization suggests TAM requires substantial modification incorporating capability constructs, cross-sectional research inadequately captures development processes, and diffusion policies focusing on awareness prove ineffective without capability support. The construct contributes to paradigm shift from technology acceptance to appropriation perspectives, where adoption unfolds through organizational learning rather than discrete decision events . Future research should examine capability development micro-processes, temporal dynamics, boundary conditions, and performance linkages across complex technologies (Algassim et al., 2023).

CONCLUSION

This study addresses a critical gap in technology adoption literature by introducing Blockchain Utilization Capability as a novel construct that reconceptualizes complex enterprise technology adoption. Empirical investigation of 300 Indonesian SMEs demonstrates that conventional TAM and TOE models inadequately explain blockchain adoption, as organizational infrastructure, environmental pressures, technological features, perceived usefulness, and perceived ease of use operate exclusively through capability development rather than directly influencing adoption intentions (Hadi Almaher et al., 2024). Five theoretical contributions emerge: establishing Capability-Mediated TAM where traditional constructs operate through capability mediation rather than direct cognitive-behavioral pathways; demonstrating organizational factors as primary capability determinants substantially exceeding environmental and technological influences; uncovering the ease-of-use paradox where simplicity perceptions paradoxically inhibit capability investment; transforming TOE from descriptive taxonomy into dynamic process model through complete capability mediation; and achieving theoretical integration whereby contextual factors and perceptual beliefs operate through common capability-building pathways (Kulkarni & Patil, 2020; Zhong & Moon, 2023). Despite cross-sectional design limitations precluding causal inference and self-report measurement constraints, the construct demonstrates robust psychometric properties with superior predictive performance. Future research should pursue longitudinal capability development studies, experimental testing of the ease paradox, multi-method validation linking capabilities to performance outcomes, and comparative studies developing parallel constructs for emerging technologies. Practically, successful blockchain adoption requires reconceptualization from technology procurement to organizational transformation, with capability development representing the essential pathway through which favorable conditions translate into implementation, justifying resource allocation to organizational readiness, formal governance, and systematic competency development before production deployment . This contributes to a paradigm shift from technology acceptance to appropriation perspectives, demonstrating that complex technology adoption unfolds through organizational learning rather than discrete decision events, requiring substantial modification of conventional acceptance models for transformative technologies.

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