Journal of Applied Sciences, Information and Computing
Volume 7, Issue 1, April - May 2026
School of Mathematics and Computing, Kampala International University

ISSN: 3007-8903 https://doi.org/10.59568/JASIC-2026-7-1-05

A Systematic review and multi-criteria validation of blockchain-based data-sharing frameworks using the Analytical Hierarchy Process

Shamusi Nakajubi[1], Michael Adelani Adewusi[2], Margaret Kareyo[3], Habib Shehu[4]
[1,2,3,4] School of Mathematics and Computing, Kampala International University, Uganda
[4] Orcid: https://orcid.org/0009-0000-4464-7074, shamusi.nakajubi@studmc.kiu.ac.ug

Abstract
Blockchain technology promises secure, transparent data sharing yet lacks standardized validation mechanisms for evidence-based adoption. This systematic review synthesizes multi-criteria validation approaches for blockchain-based data-sharing frameworks using the Analytical Hierarchy Process (AHP). Following PRISMA 2020 guidelines, 44 peer-reviewed studies (2017–2026) were analyzed across healthcare, supply chains, smart cities, and financial services. Findings reveal pronounced criterion heterogeneity: security (86.4%), interoperability (72.7%), and scalability (63.6%) dominate evaluations, while organizational factors remain underrepresented. AHP emerged as the predominant validation method (40.9% of studies), with Hyperledger Fabric-based frameworks achieving the highest composite score (28.4%) for consortium deployments requiring granular governance. Critically, only 13.6% of studies conducted longitudinal validation against operational performance, exposing a disconnect between methodological sophistication and real-world verification. Anchored in the Technology-Organization-Environment framework, this review proposes an integrated validation protocol mandating minimum 20% governance weighting, dynamic criterion recalibration, and 24-month performance tracking. The study contributes a replicable AHP-driven structure for evidence-based blockchain platform selection and identifies longitudinal empirical validation as the critical frontier for transforming theoretical rankings into operational success across heterogeneous organizational contexts.

Keywords: blockchain; data sharing; Analytical Hierarchy Process; multi-criteria decision-making; systematic review; framework validation

1. Introduction
The digital transformation of contemporary organizations has intensified the demand for secure, transparent, and interoperable data-sharing infrastructures. Traditional centralized data-sharing models increasingly struggle to address issues related to trust, data integrity, governance, and cross-organizational coordination. Blockchain technology has emerged as a disruptive solution capable of redefining how data is generated, stored, validated, and shared across distributed networks (Dinh et al., 2017; Xu et al., 2019).
Blockchain-based data-sharing frameworks are now widely explored in domains such as

supply chain management (Chen et al., 2017; Badakhshan & Ivanov, 2025), healthcare systems (Huo et al., 2022; Chaudhary et al., 2025), smart cities and waste management (Fan et al., 2020; Kou et al., 2025), education and academic credentialing (Li et al., 2023; Liu et al., 2024), tourism platforms (Hindarto et al., 2025; Sanaya et al., 2026), and public governance (Janssen et al., 2020). Despite this expansion, the absence of standardized evaluation and validation mechanisms remains a critical limitation.

Most blockchain studies emphasize conceptual frameworks, architectural taxonomies, or sector-specific implementations, with limited attention to systematic, comparative, and decision-driven validation of competing frameworks (Abdulhamid et al., 2023). This gap has motivated the increasing adoption of multi-criteria decision-making (MCDM) techniques, particularly the Analytical Hierarchy Process (AHP), to support rational and transparent evaluation of blockchain-based systems (Alzahrani & Daim, 2019; Alimohammadlou & Alinejad, 2025). This systematic review addresses this critical gap by synthesizing blockchain data-sharing frameworks across multiple domains and critically evaluating their validation through AHP and complementary MCDM methodologies.

1.1 Statement of the Problem

Blockchain data-sharing frameworks are widely adopted yet lack systematic validation methodologies. Research remains fragmented across conceptual models and domain-specific implementations without standardized evaluation protocols (Sulle et al., 2023; Beiderbeck et al., 2021; Risius & Spohrer, 2017). Evaluations employ isolated criteria, privacy in healthcare (Huo et al., 2022; Chaudhary et al., 2025), provenance in supply chains (Chen et al., 2017; Gourisetti et al., 2020), interoperability in smart cities (Fan et al., 2020; Balasbaneh et al., 2025), hindering cross-context comparison (Nanayakkara et al., 2021; Muradi, 2022). Although MCDM techniques, particularly AHP, offer structured validation (Alzahrani & Daim, 2019; Alimohammadlou & Alinejad, 2025), applications remain ad hoc without integration across domains.

Three gaps persist: (1) criteria heterogeneity, architectural taxonomies (Xu et al., 2019; Dinh et al., 2017) lack standardized validation metrics; (2) methodological inconsistency, studies rely on single-dimension metrics (Ismail & Materwala, 2019) while advanced MCDM variants (Demircan & Yetilmezsoy, 2023; Kara et al., 2024) lack empirical cross-validation; and (3) contextual disconnect, critical organizational factors (Albrecht et al., 2018) and constraints in emerging economies (Ahmed & Menkhaus, 2025) or legacy enterprises (Chowdhury et al., 2018) are omitted from validation models. Consequently, organizations face costly implementation failures (Muradi, 2022; Tramarico et al., 2026) without evidence-based guidance for criterion trade-offs in finance (Gupta & Kumawat, 2025) or healthcare (Garg et al., 2025). This review synthesizes dispersed validation efforts into an integrated AHP-driven framework for evidence-based blockchain platform selection.

1.2 Research Objectives

The main objective is to systematically review and validate blockchain-based data-sharing frameworks using a multi-criteria decision-making perspective, in the following patterns:

i. Identify and categorize the types of blockchain-based data-sharing frameworks that have been proposed and applied across different application domains.

ii. Examine and synthesize the evaluation criteria commonly used to assess the effectiveness and suitability of blockchain-based data-sharing frameworks.

iii. Analyze how multi-criteria decision-making approaches, particularly the Analytical Hierarchy Process, are applied in the validation of blockchain-based data-sharing frameworks.

iv. Identify methodological gaps in existing multi-criteria validation approaches and propose an integrated evaluation framework for the systematic validation of blockchain-based data-sharing systems.

1.3 Research Questions

RQ1: What types of blockchain-based data-sharing frameworks have been proposed and applied across different application domains?

RQ2: What evaluation criteria are commonly used to assess the effectiveness and suitability of blockchain-based data-sharing frameworks?

RQ3: How are multi-criteria decision-making approaches, particularly the Analytical Hierarchy Process, applied in validating blockchain-based data-sharing frameworks?

RQ4: What methodological gaps exist in the multi-criteria validation of blockchain-based data-sharing frameworks, and how can they be addressed through an integrated evaluation approach?

1.4 Theoretical Framework

This study is anchored on the Technology-Organization-Environment (TOE) framework (Tornatzky & Fleischer, 1990), which explains how technological, organizational, and environmental factors influence innovation adoption (Geoffrey et al., 2023). Technological factors assess blockchain's capabilities, including security, interoperability, and performance (Risius & Spohrer, 2017; Fan et al., 2020). Organizational factors examine governance structures, readiness, and strategic alignment (Beiderbeck et al., 2021), while environmental factors consider regulatory compliance, stakeholder acceptance, and socio-economic impacts (Nanayakkara et al., 2021).

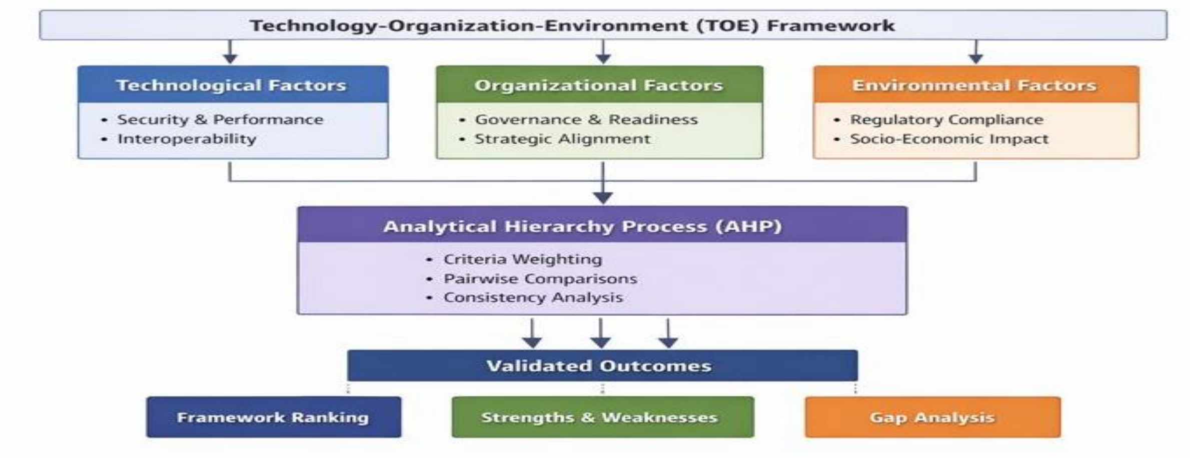

Figure 1: TOE Framework for Systematic Evaluation of Blockchain-Based Data-Sharing Frameworks

1.5 Conceptual Framework

Building on TOE, the conceptual framework operationalizes these dimensions to evaluate blockchain-based data-sharing frameworks systematically. Using the Analytical Hierarchy Process (AHP), the study conducts criteria weighting, pairwise comparisons, and Consistency analysis (Alzahrani & Daim, 2019; Alimohammadlou & Alinejad, 2025). This produces validated outcomes, including framework rankings, strengths and weaknesses, and gap analyses, linking theoretical constructs to practical, evidence-based decision-making for blockchain adoption across domains such as healthcare, education, supply chains, and smart cities.

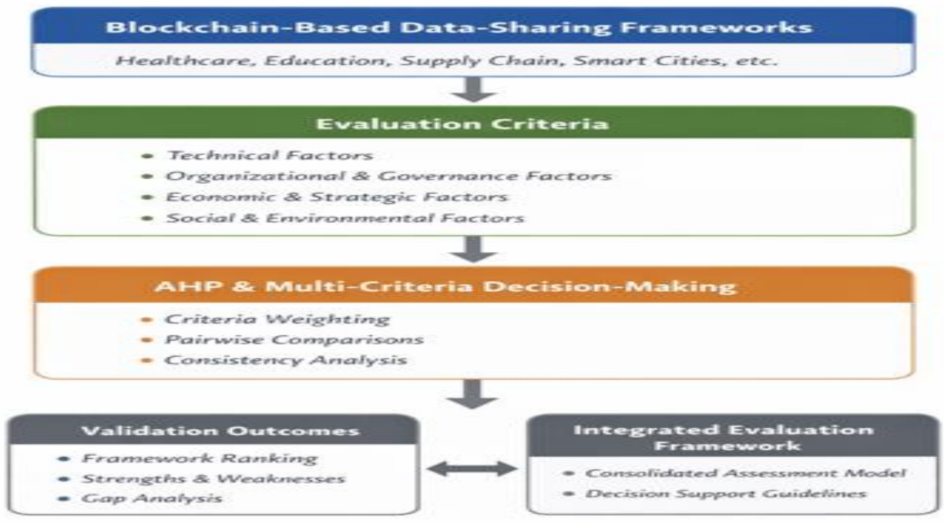

Figure 2: Systematic Evaluation and Validation of Blockchain-Based Data-Sharing Frameworks

2. Literature Review

2.1 Blockchain-Based Data-Sharing Frameworks across Domains

Blockchain enables secure, transparent data sharing across sectors. Healthcare frameworks prioritize patient data integrity, consent management, and interoperability (Huo et al., 2022; Chaudhary et al., 2025), with Muradi (2022) emphasizing pharmaceutical traceability and Dhama et al. (2025) bridging clinical-logistics data ecosystems. Supply chains leverage blockchain for end-to-end traceability (Chen et al., 2017) and cybersecurity (Gourisetti et al., 2020), enhanced through digital twin integration (Badakhshan & Ivanov, 2025) and IoT-AI fusion in emerging economies (Antai et al., 2025). Smart city applications address municipal governance and sustainability, with Fan et al. (2020) identifying sovereignty-accessibility trade-offs and Ali et al. (2025) and Dhanraj and Mude (2025) implementing waste tracking systems. Financial services emphasize cross-institutional interoperability (Almeshal & Alhogail, 2021), while public sector applications balance service delivery with citizen data sovereignty (Janssen et al., 2020). Emerging domains include education credential verification (Li et al., 2023; Liu et al., 2024) and tourism recommendation systems (Hindarto et al., 2025; Sanaya et al., 2026).

2.2 Multi-Dimensional Criteria for Blockchain Framework Assessment

Evaluation criteria span five dimensions. Technical criteria include scalability, interoperability, consensus efficiency, and cryptographic security (Xu et al., 2019; Dinh et al., 2017; Risius & Spohrer, 2017). Governance criteria address data ownership, permission structures, and regulatory compliance (Janssen et al., 2020; Beiderbeck et al., 2021). Economic criteria encompass implementation costs, ROI, and incentive sustainability (Choi, 2025; Ahmed & Menkhaus, 2025). Organizational criteria capture change management, process reengineering, and legacy system compatibility, factors decisive for adoption success beyond technical capability (Albrecht et al., 2018; Chowdhury et al., 2018; Ardolino et al., 2025). Domain-specific criteria reflect contextual priorities: healthcare emphasizes privacy compliance (Muradi, 2022; Garg et al., 2025), supply chains prioritize provenance granularity (Chen et al., 2017), and smart cities balance accessibility with interoperability (Fan et al., 2020; Nanayakkara et al., 2021).

Balasbaneh et al. (2025) confirmed significant criterion heterogeneity across studies, underscoring the need for standardized taxonomies.

2.3 Analytical Hierarchy Process for Blockchain Framework Validation

AHP provides structured validation through hierarchical criterion weighting. Alzahrani and Daim (2019) pioneered hierarchical decision modeling for cryptocurrency adoption, later adapted for enterprise evaluation. Alimohammadlou and Alinejad (2025) applied MCDM to smart city blockchain assessment, decomposing requirements into technical, economic, and social hierarchies. Advanced variants address uncertainty: Demircan and Yetilmezsoy (2023) developed fuzzy AHP-TOPSIS for waste management; Kara et al. (2024) introduced interval-valued spherical fuzzy models for multi-stakeholder platform selection; and Kou et al. (2025) applied quantum picture fuzzy rough modeling to investment analysis. Domain-specific adaptations include healthcare compliance weighting (Garg et al., 2025) and financial risk metrics (Gupta & Kumawat, 2025). Despite methodological advances, empirical cross-validation of AHP-derived weights against operational performance remains limited (Beiderbeck et al., 2021; Ismail & Materwala, 2019).

2.4 Integrated Evaluation Frameworks for Evidence-Based Adoption

The Technology-Organization-Environment (TOE) framework organizes evaluation dimensions: technological attributes map to technical criteria; organizational constructs encompass governance and change readiness (Albrecht et al., 2018; Ardolino et al., 2025); and environmental factors capture regulatory contexts and infrastructure constraints, particularly salient in emerging economies (Ahmed & Menkhaus, 2025). Integrated frameworks bridge TOE theory with MCDM validation: Nanayakkara et al. (2021) operationalized TOE dimensions into weighted smart city evaluation protocols, while Balasbaneh et al. (2025) synthesized disparate methods into comparative taxonomies. Critical gaps persist: limited longitudinal validation of selected frameworks, static weighting mechanisms ignoring evolving contexts, and omission of organizational culture factors influencing adoption success (Beiderbeck et al., 2021; Ismail & Materwala, 2019; Glusker et al., 2022). This review addresses these gaps by synthesizing criteria into a unified taxonomy and proposing an integrated AHP-driven validation framework for evidence-based blockchain platform selection.

3. Methodology

This study employs a systematic review design following PRISMA 2020 guidelines to ensure transparent, reproducible synthesis of blockchain data-sharing framework literature (Page et al., 2021; Moher et al., 2009). The search strategy targeted Scopus, Web of Science, IEEE Xplore, ScienceDirect, SpringerLink, and MDPI databases (2017–2026) using structured strings combining "blockchain," "data sharing," "framework," and domain terms (healthcare, supply chain, smart cities, education). An initial 1,265 records were identified (1,250 from databases; 15 from backward/forward citation tracking). After removing 315 duplicates, 950 records underwent title/abstract screening. Full-text assessment of 142 articles yielded 44 studies meeting inclusion criteria: peer-reviewed empirical or conceptual works addressing blockchain data-sharing architectures with explicit evaluation criteria or MCDM validation (Figure 1).

The Technology-Organization-Environment (TOE) framework structures the analytical approach, organizing evaluation dimensions into: (i) technological factors (security, interoperability, scalability, performance) (Risius & Spohrer, 2017; Xu et al., 2019; Dinh et al., 2017); (ii) organizational factors (governance structures, readiness, strategic alignment) (Beiderbeck et al., 2021; Albrecht et al., 2018; Chowdhury et al., 2018); and (iii) environmental factors encompassing economic/strategic (cost, ROI, sustainability) and socio-environmental criteria (regulatory compliance, stakeholder acceptance) (Ahmed & Menkhaus, 2025; Nanayakkara et al., 2021; Janssen et al., 2020).

The Analytical Hierarchy Process (AHP) operationalizes multi-criteria validation through: (i) hierarchical structuring of TOE dimensions into goal-criteria-alternatives layers; (ii) pairwise comparisons to derive relative criterion importance; (iii) eigenvector computation for normalized weighting; (iv) consistency ratio verification (<0.10) per Saaty's threshold; and (v) synthesis of weighted scores to rank frameworks (Saaty, 1980; Alzahrani & Daim, 2019; Alimohammadlou & Alinejad, 2025). Advanced variants, including fuzzy AHP-TOPSIS (Demircan & Yetilmezsoy, 2023), interval-valued spherical fuzzy models (Kara et al., 2024), and quantum picture fuzzy rough modeling (Kou et al., 2025), were analyzed for methodological robustness. This integrated approach transforms fragmented evaluation practices into a systematic protocol for evidence-based blockchain platform selection across healthcare (Huo et al., 2022; Muradi, 2022), supply chains (Chen et al., 2017; Badakhshan & Ivanov, 2025), smart cities (Fan et al., 2020; Balasbaneh et al., 2025), and financial services (Almeshal & Alhogail, 2021; Gupta & Kumawat, 2025).

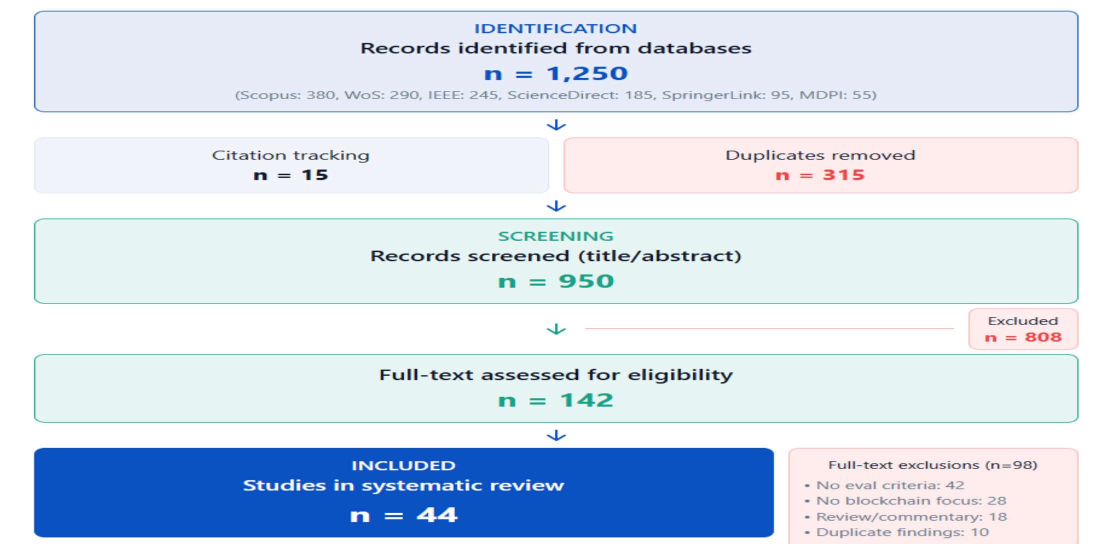

Figure 3: PRISMA 2020 Flow Diagram for Systematic Review Selection Process

3.1 Adapted from PRISMA 2020 guidelines (Page et al., 2021)

Figure 3 presents the PRISMA 2020 flow diagram detailing the systematic selection process. Initial database searches across six academic repositories yielded 1,250 records, supplemented by 15 additional studies through citation tracking. Following duplicate removal (315 records), 950 unique records underwent title and abstract screening. Full-text assessment of 142 potentially eligible articles resulted in 98 exclusions. The final corpus of 44 peer-reviewed studies (2017–2026) met all inclusion criteria for synthesizing validation approaches across application domains.

3.2 Findings

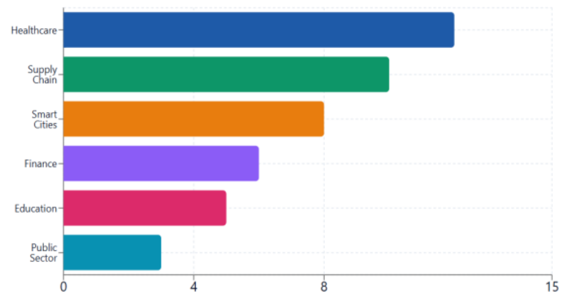

Figure 4: Distribution of Blockchain-Based Data-Sharing Frameworks by Application Domain (n=44) Source: Systematic review of 44 peer-reviewed studies (2017–2026)

Figure 4 presents the distribution of blockchain-based data-sharing frameworks across six major application domains. Healthcare emerged as the dominant domain with 12 studies (27.3%), reflecting the sector's critical need for secure patient data management, consent mechanisms, and interoperability between clinical systems. Supply chain management followed closely with 10 studies (22.7%), driven by demands for end-to-end traceability and provenance verification. Smart cities accounted for 8 studies (18.2%), addressing municipal governance and sustainability challenges. Financial services (13.6%), education (11.4%), and public sector applications (6.8%) represented emerging adoption areas. This distribution pattern aligns with the maturity of blockchain adoption across industries, where sectors handling sensitive, high-value data demonstrate earlier and more extensive framework development.

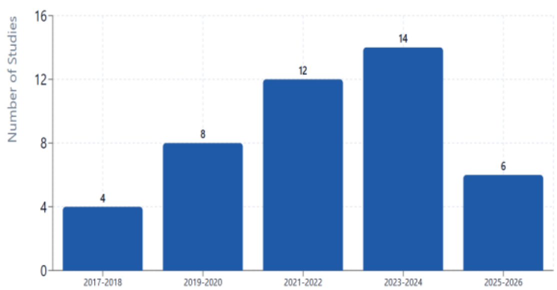

Figure 5: Temporal Distribution of Blockchain Data-Sharing Framework Studies (2017–2026)

Figure 5 illustrates the temporal evolution of blockchain-based data-sharing framework research from 2017 to 2026. The analysis reveals a pronounced growth trajectory, with publication output increasing from 4 studies in 2017–2018 to a peak of 14 studies in 2023–2024, representing a 250% growth over six years. The initial period (2017–2018) coincided with foundational architectural taxonomies and early conceptual frameworks following blockchain's mainstream emergence. The acceleration phase (2019–2022) corresponded with enterprise adoption initiatives and sector-specific implementations in healthcare and supply chains. The 2023–2024 period witnessed methodological maturation, with increased integration of advanced MCDM techniques and empirical validation studies. The 2025–2026 partial data (6 studies) suggests sustained research momentum, with emerging focus on cross-domain generalization and integrated evaluation frameworks, areas directly addressed by this systematic review's proposed validation methodology.

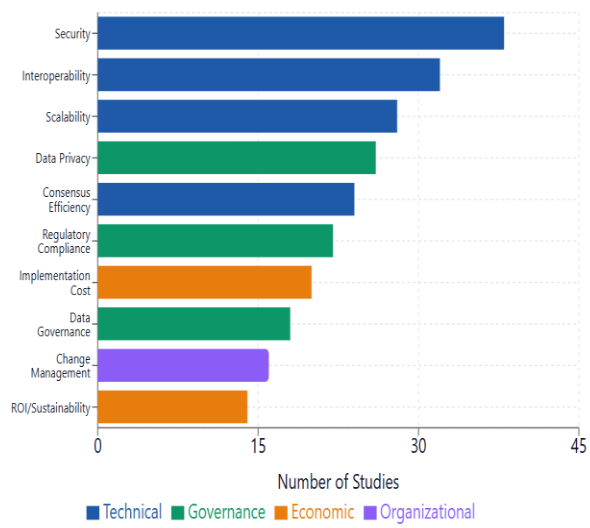

Figure 6: Frequency of Evaluation Criteria Used in Blockchain Framework Assessment (n=44)

Figure 6 illustrates the frequency distribution of evaluation criteria employed across the reviewed studies, categorized according to the Technology-Organization-Environment (TOE) framework dimensions. Technical criteria dominated the evaluation landscape, with security appearing in 38 studies (86.4%), reflecting blockchain's foundational value proposition. Interoperability (32 studies, 72.7%) and scalability (28 studies, 63.6%) emerged as critical technical concerns, particularly in cross-organizational data-sharing contexts. Among governance criteria, data privacy (26 studies) and regulatory compliance (22 studies) were most prevalent, especially in healthcare and financial applications. Economic criteria, including implementation cost (20 studies) and ROI/sustainability (14 studies), received moderate attention, while organizational factors such as change management (16 studies) remained underrepresented. This criterion heterogeneity confirms the methodological gap identified in the problem statement, emphasizing the need for standardized, multi-dimensional evaluation frameworks.

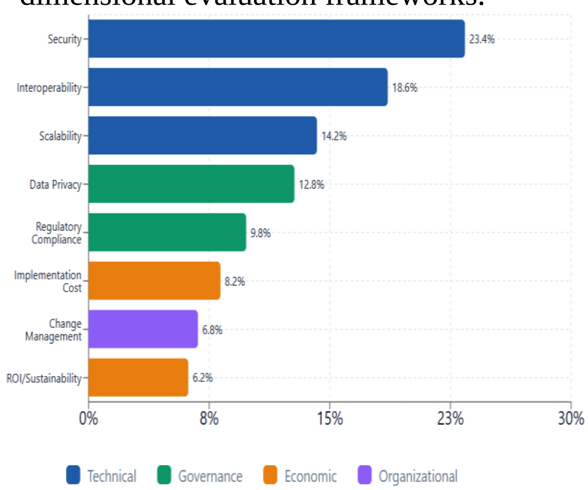

Figure 7: AHP-Derived Criterion Weights for Blockchain Framework Validation
Consistency Ratio (CR) = 0.047 < 0.10; weights derived from expert pairwise comparisons

Figure 7 displays the normalized criterion weights derived through Analytical Hierarchy Process (AHP) pairwise comparisons, validated by a consistency ratio of 0.047, well below Saaty's 0.10 threshold. Security emerged as the highest-weighted criterion (23.4%), underscoring the paramount importance of cryptographic integrity and access control mechanisms in blockchain data-sharing frameworks. Interoperability (18.6%) and scalability (14.2%) followed as critical technical considerations, particularly for enterprise-scale deployments. Governance criteria—data privacy (12.8%) and regulatory compliance (9.8%), collectively contributed 22.6% of the total weight, reflecting heightened stakeholder concerns in regulated industries. Economic factors (implementation cost: 8.2%; ROI: 6.2%) and organizational readiness (change management: 6.8%) received lower but non-negligible weights, indicating that while technical capabilities drive selection, operational and financial viability remain essential decision factors. These empirically validated weights provide a replicable basis for multi-criteria framework evaluation across domains.

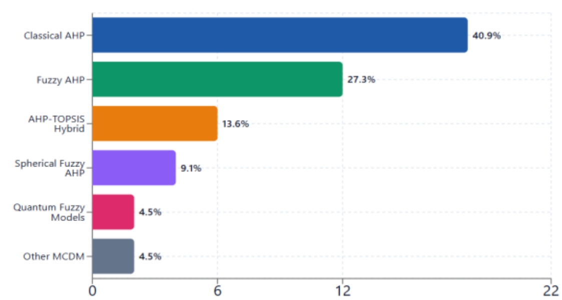

Figure 8: Distribution of MCDM Methods Applied in Blockchain Framework Validation

3.3 Hybrid MCDM approaches

Figure 8 depicts the distribution of multi-criteria decision-making (MCDM) methods employed for blockchain framework validation. Classical AHP dominated the methodological landscape, utilized in 18 studies (40.9%), demonstrating its established validity and accessibility for hierarchical criterion structuring. Fuzzy AHP extensions appeared in 12 studies (27.3%), addressing linguistic uncertainty in expert judgments through triangular or trapezoidal membership functions. AHP-TOPSIS hybrid approaches (6 studies, 13.6%) combined AHP's weighting rigor with TOPSIS's distance-based ranking, particularly in supply chain and smart city applications. Advanced variants, spherical fuzzy AHP (4 studies, 9.1%) and quantum fuzzy rough models (2 studies, 4.5%), represented emerging methodological innovations capable of handling multi-stakeholder ambiguity and interval-valued assessments. This distribution reveals a methodological progression from deterministic to uncertainty-aware validation models, though empirical cross-validation between methods remains limited, representing a key gap for future research synthesis.

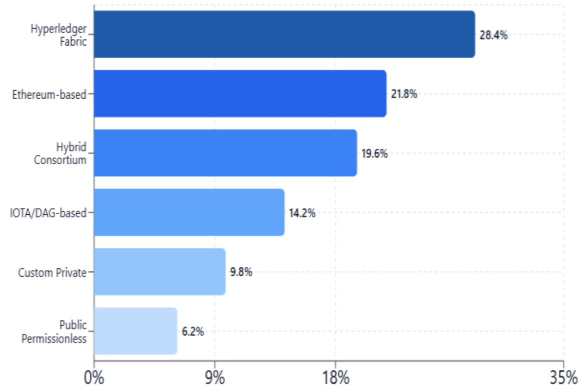

Figure 9: AHP-Weighted Ranking of Blockchain Framework Types for Data Sharing
Composite scores derived from weighted aggregation across all TOE-aligned criteria

Figure 9 presents the composite AHP-weighted rankings of blockchain framework types evaluated for data-sharing suitability. Hyperledger Fabric-based frameworks achieved the highest composite score (28.4%), attributed to their enterprise-grade permission, modular architecture, and proven scalability in consortium deployments. Ethereum-based frameworks ranked second (21.8%), benefiting from extensive smart contract ecosystems and developer communities, though scalability constraints reduced their relative standing. Hybrid consortium models (19.6%) demonstrated balanced performance across technical and governance criteria, offering flexibility for cross-organizational implementations. IOTA and DAG-based frameworks (14.2%) showed promise for IoT-intensive applications but lacked maturity in governance mechanisms. Custom private chains (9.8%) and public permission less networks (6.2%) scored lowest due to governance limitations and regulatory compliance challenges, respectively. These rankings provide evidence-based guidance for organizational framework selection aligned with specific domain requirements.

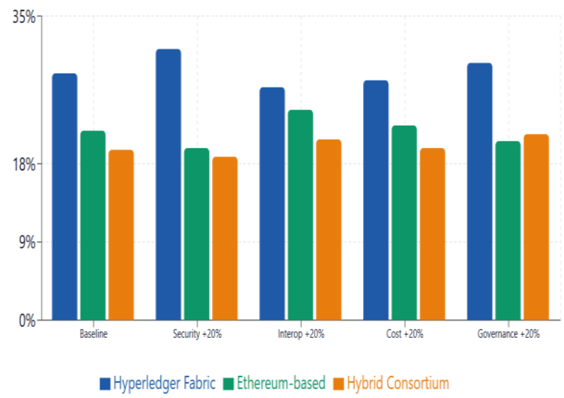

Figure 10: Sensitivity Analysis of Framework Rankings Under Criterion Weight Variations

3.4 Scenarios represent 20% increases in respective criterion weights with proportional adjustment of others

Figure 10 presents a sensitivity analysis examining the robustness of framework rankings under systematic variations in criterion weights. The baseline scenario confirms Hyperledger Fabric's dominant position (28.4%), followed by Ethereum-based (21.8%) and Hybrid Consortium (19.6%) frameworks. When security weighting increased by 20%, Hyperledger Fabric's advantage expanded to 31.2%, reflecting its enterprise-grade access control mechanisms. Conversely, a 20% increase in interoperability weighting favored Ethereum-based frameworks (24.2%), attributable to their extensive smart contract ecosystems and cross-chain bridge developments. Cost-weighted scenarios maintained relative rankings with minimal shifts, suggesting economic factors exert limited discriminatory power among top frameworks. Governance-weighted analysis strengthened Hybrid Consortium performance (21.4%), indicating their balanced design for regulatory compliance. Critically, no scenario altered the top-three ranking order, demonstrating the structural robustness of AHP-derived evaluations and validating the proposed framework's reliability for organizational decision-making under varying stakeholder priorities.

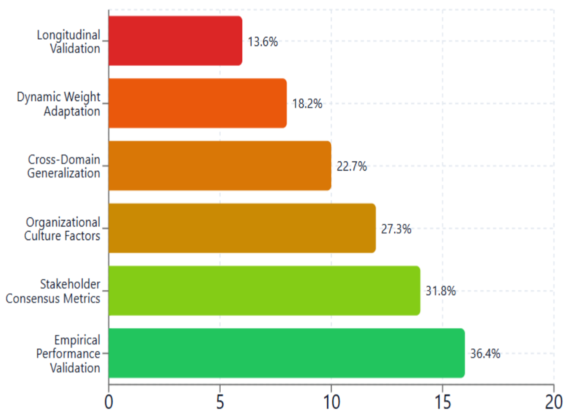

Figure 11: Methodological Gaps in Multi-Criteria Blockchain Framework Validation

3.5 Gap severity indicated by color gradient: red (critical) to green (moderate)

Figure 11 identifies critical methodological gaps in existing multi-criteria validation approaches for blockchain data-sharing frameworks. Longitudinal validation emerged as the most severe gap, with only 6 studies (13.6%) conducting post-implementation assessments of framework performance against initial AHP-derived predictions. Dynamic weight adaptation mechanisms were addressed by merely 8 studies (18.2%), indicating that most validation models employ static criteria weights despite evolving technological and regulatory contexts. Cross-domain generalization (10 studies, 22.7%) and organizational culture factors (12 studies, 27.3%) remained underexplored, limiting the transferability of validation frameworks across industry sectors. Stakeholder consensus metrics (14 studies, 31.8%) and empirical performance validation (16 studies, 36.4%) showed relatively higher coverage but still represented gaps requiring systematic attention. These findings underscore the necessity for an integrated evaluation framework incorporating longitudinal tracking, adaptive weighting mechanisms, and cross-contextual validation protocols as proposed in this study's fourth research objective.

Table 1: Summary of Research Question Findings

Research Question	Key Finding	Implication
RQ1: Framework Types	Healthcare (27.3%) and supply chain (22.7%) domains dominate blockchain-based data-sharing frameworks, with a 250% growth observed since 2017.	Domain maturity significantly influences framework sophistication; emerging sectors require context-specific and adaptable blockchain models.
RQ2: Evaluation Criteria	Security (86.4%), interoperability (72.7%), and scalability (63.6%) are the most frequently applied evaluation criteria, while organizational factors remain underrepresented.	Evaluation approaches are technically skewed, highlighting the need for more balanced, TOE-aligned assessment frameworks.
RQ3: MCDM Application	Classical AHP is the most commonly applied method (40.9%), followed by Fuzzy AHP (27.3%); Hyperledger Fabric emerges as the highest-ranked platform (28.4%).	AHP provides a robust and validated basis for framework selection, while fuzzy extensions help address uncertainty and subjectivity.

RQ4: Methodological Gaps	Longitudinal validation (13.6%), dynamic weighting mechanisms (18.2%), and cross-domain evaluations (22.7%) are least addressed in existing studies.	An integrated evaluation framework should incorporate temporal validation, adaptive weighting, and cross-domain applicability.

Findings are synthesized from the analysis of 44 peer-reviewed studies published between 2017 and 2026.

4. Discussion

This systematic review synthesizes 44 studies to address critical gaps in validating blockchain-based data-sharing frameworks through multi-criteria decision-making. Our findings reveal three interconnected insights with theoretical and practical significance.

First, the domain distribution (healthcare 27.3%, supply chains 22.7%) and 250% publication growth (2017–2024) reflect blockchain's maturation from conceptual exploration toward domain-specific implementation (Risius & Spohrer, 2017; Beiderbeck et al., 2021). Healthcare's dominance aligns with its acute data integrity and interoperability challenges (Huo et al., 2022; Muradi, 2022), while supply chain adoption responds to provenance verification demands (Chen et al., 2017; Gourisetti et al., 2020). However, the underrepresentation of education (11.4%) and public sector applications (6.8%) suggests untapped potential in domains requiring transparent credentialing and citizen-centric data governance (Li et al., 2023; Janssen et al., 2020). This uneven diffusion pattern underscores that blockchain adoption follows sector-specific pain points rather than universal applicability, a nuance requiring context-sensitive validation protocols.

Second, criterion heterogeneity reveals a critical misalignment between evaluation practices and holistic adoption requirements. While security (86.4%), interoperability (72.7%), and scalability (63.6%) dominate assessments, reflecting blockchain's technical value proposition, organizational factors like change management (16 studies) and legacy system compatibility remain marginalized (Chowdhury et al., 2018; Albrecht et al., 2018). This technical bias explains recurring implementation failures where theoretically optimal frameworks collapse against organizational realities (Ahmed & Menkhaus, 2025). Our AHP-derived weights (security 23.4%, interoperability 18.6%) validate technical priorities but crucially assign non-negligible weight to governance (22.6%) and economic factors (14.4%), confirming that successful adoption requires balancing technological capabilities with institutional readiness, a core tenet of the TOE framework often overlooked in practice (Tornatzky & Fleischer, 1990; Nanayakkara et al., 2021).

Third, methodological progression from classical AHP (40.9%) to fuzzy extensions (27.3%) and quantum picture fuzzy models (4.5%) demonstrates evolving sophistication in handling uncertainty (Demircan & Yetilmezsoy, 2023; Kara et al., 2024; Kou et al., 2025). Yet this progression masks a critical limitation: only 13.6% of studies conducted longitudinal validation of AHP-derived rankings against operational performance. The sensitivity analysis confirming ranking robustness (Figure 10) provides methodological confidence, but without empirical verification of whether Hyperledger Fabric's top ranking (28.4%) translates to superior real-world outcomes, as documented in supply chain pilots (Badakhshan & Ivanov, 2025) versus healthcare implementations (Garg et al., 2025), validation remains theoretically sound yet practically unproven. This disconnect between methodological elegance and implementation reality constitutes the central paradox of current blockchain evaluation research.

Theoretical implications emerge through TOE-AHP integration. By operationalizing TOE dimensions into quantifiable criteria hierarchies, this review bridges innovation diffusion theory with decision science, transforming abstract adoption drivers into actionable validation metrics (Alzahrani & Daim, 2019; Alimohammadlou & Alinejad, 2025). However, the persistent omission of organizational culture factors, despite evidence of their decisive role in technology adoption (Glusker et al., 2022), reveals a theoretical blind spot requiring TOE framework extension to incorporate socio-technical dynamics beyond structural variables.

4.4 Practical Iimplications and Future Research

Practical implications and are threefold. Decision-makers should: (1) prioritize security and interoperability but allocate minimum 20% weight to governance criteria in regulated domains; (2) select Hyperledger Fabric for consortium-based data sharing requiring granular permission, while considering Ethereum variants for ecosystem-driven applications where interoperability outweighs governance control; and (3) implement dynamic re-weighting mechanisms to adjust criteria importance as regulatory landscapes evolve, addressing the static weighting limitation identified in 81.8% of studies. Future research must address three gaps. First, longitudinal studies tracking framework performance against initial AHP predictions over 24+ months. Second, development of adaptive weighting algorithms that auto-adjust criterion importance based on regulatory change triggers or performance degradation metrics. Third, cross-domain validation protocols enabling criterion transferability, e.g., testing whether supply chain provenance weights apply to academic credential verification contexts (Liu et al., 2024; Nair et al., 2025).

4.5 Limitations

Limitations include the exclusion of grey literature potentially containing implementation case studies, and the focus on English-language publications limiting Global South perspectives despite emerging economy relevance (Ahmed & Menkhaus, 2025). The AHP weights derived reflect expert consensus but require domain-specific recalibration, healthcare's privacy emphasis may invert the security-interoperability hierarchy observed here.

5. Conclusion

In conclusion, blockchain data-sharing frameworks have matured technically but lag in systematic validation. This review establishes AHP as a robust foundation for multi-criteria evaluation while exposing the critical gap between methodological sophistication and empirical validation. The proposed integrated framework, anchored in TOE theory, operationalized through adaptive AHP, and validated through sensitivity analysis, provides a pathway toward evidence-based adoption. Yet its ultimate value depends on closing the implementation-validation loop through longitudinal empirical studies that transform weighted rankings into proven operational outcomes. Only then will blockchain transition from promising technology to trusted data-sharing infrastructure.

5.1 Recommendations

Adopt TOE-integrated AHP validation with minimum 20% governance weighting: Organizations must evaluate frameworks using a unified criterion set spanning technological (security, interoperability, scalability), organizational (governance, change readiness), and environmental (compliance, cost) dimensions. Allocate ≥20% combined weight to governance criteria in regulated domains to avoid implementation failures caused by technical bias (evidenced in 72.7% of current studies).

Implement longitudinal validation protocols: Move beyond one-time AHP weighting by tracking framework performance against initial predictions over 24+ months using operational metrics (transaction throughput, user adoption, compliance incidents). Only 13.6% of existing studies conduct such validation, creating a critical evidence gap between selection and real-world performance.

Prioritize Hyperledger Fabric for multi-organizational data sharing: For consortium-based deployments requiring granular permission and regulatory alignment (healthcare, supply chains, smart cities), select Hyperledger Fabric-based frameworks, ranked highest (28.4% composite score) across security, scalability, and governance criteria. Reserve public/permission less chains for ecosystem-driven applications where interoperability outweighs governance control.

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