LEVERAGING BLOCKCHAIN FOR STRATEGIC TRANSFORMATION IN AGRICULTURAL GOVERNANCE AND SUSTAINABILITY: A PRISMA-GUIDED, PICO-INFORMED THEMATIC META-SYNTHESIS OF DEVELOPING ECONOMIES

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Abstract

Blockchain technology holds transformative potential for enhancing transparency, efficiency, and sustainability in public-sector agriculture. This study investigates how blockchain can be strategically embedded within agricultural governance systems in developing economies, where policy implementation is often hindered by fragmented data infrastructures, institutional inefficiencies, and limited transparency. Using a PRISMA-guided, PICO (Population, Intervention, Comparator, Outcomes) informed qualitative meta-synthesis of 50 peer-reviewed studies (2014–2024), the research identifies six strategic domains: governance and trust, operational efficiency, data integration, smart contracts, sustainability, and stakeholder inclusion. Across these domains, blockchain enables traceability, deters corruption, automates subsidy distribution, and facilitates environmental monitoring. These findings build on prior research emphasizing blockchain's institutional value in public auditing and decentralized decision-making (Shang & Price, 2019; Mavilia & Pisani, 2022). However, challenges such as high deployment costs, digital literacy gaps, and infrastructure constraints remain significant. The study concludes that blockchain — when aligned with national digital transformation agendas and Sustainable Development Goals (SDGs; notably SDG 6 and 13) — can serve as a policy-enabling infrastructure for inclusive, transparent, and sustainable agricultural governance, with broader applicability to other developing contexts.

Keywords: Blockchain Governance, Agricultural Policy, Public Sector Innovation, Digital Transformation, Meta-Synthesis, PRISMA, Thematic Analysis, Developing Economies, Institutional Reform, Data Transparency

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1. INTRODUCTION

Agriculture remains a cornerstone of economic development in many low- and middle-income countries, yet it often suffers from institutional inefficiencies and governance challenges. As demands for transparency, efficiency, and food system resilience grow, blockchain has emerged as a promising innovation with strategic implications. In Thailand, despite favorable geography, persistent issues such as low productivity, high costs, and farmer debt continue to hinder competitiveness. To address these challenges, national strategies emphasize sustainability, cost reduction, and resilience (Ministry of Agriculture and Cooperatives [MOAC], 2023), with the MOAC driving digital reform to improve transparency and data interoperability.

Blockchain's decentralized structure, secure verification, and smart contract features enable real-time monitoring, reduce human error, and support stakeholder trust. These attributes align closely with Thailand's goals in operational efficiency and fiscal integrity. More broadly, blockchain adoption reflects a move toward participatory governance, positioning farmers and public agencies as partners in reform. However, much of the existing research remains fragmented, focusing narrowly on technical trials rather than systemic transformation or alignment with Sustainable Development Goals (SDGs), such as Zero Hunger (SDG 2) and Innovation Infrastructure (SDG 9).

This study explores how blockchain can be embedded into Thailand's agricultural governance to enhance transparency, efficiency, and sustainable development. Drawing on digital governance theory (Tan et al., 2022) and institutional capability perspectives, the study adopts a qualitative meta-synthesis of 50 peer-reviewed studies (2014–2024). Using PRISMA and PICO (Population, Intervention, Comparator, Outcomes) frameworks alongside thematic analysis (Nowell et al., 2017), it identifies recurring governance themes and institutional dynamics.

The study aims to:

1) examine the blockchain's strategic role in Thai agricultural policy;

2) synthesize international insights on public-sector blockchain adoption;

3) identify implementation barriers and enablers;

4) propose policy recommendations for MOAC.

This paper is organized into six sections. Section 1 outlines the research context, significance, and central question. Section 2 reviews the literature and presents theoretical foundations concerning blockchain, governance, and agricultural transformation. Section 3 details the research methodology, including the PRISMA and PICO frameworks and thematic analysis procedures. Section 4 reports the meta-synthesis results across six strategic themes. Section 5 discusses the implications for blockchain adoption in Thailand's public agricultural sector. Finally, Section 6 concludes by summarizing key contributions, limitations, and directions for future inquiry.

2. LITERATURE REVIEW

2.1. Methodological foundations for meta-synthesis

To address the complexity of blockchain adoption in Thailand's agricultural governance, this study applies a qualitative synthesis approach combining meta-synthesis, the PRISMA framework, the PICO model, and thematic analysis to ensure methodological rigor and transparency. Meta-synthesis, introduced by Glass (1976), involves aggregating qualitative findings to derive broader insights and is particularly suited to interdisciplinary domains like agricultural governance. In this context, it facilitates the integration of empirical and theoretical perspectives on blockchain's role, supporting a coherent narrative linking technology, institutions, and policy. The study employs the PRISMA protocol to guide systematic and replicable literature screening, while the PICO model — originally from medical research (Frandsen et al., 2020) — is adapted here to define structured inclusion criteria for governance studies. The extracted data are analyzed through thematic analysis, an iterative method suited for identifying conceptual patterns in complex institutional settings. As noted by Mudjisusatyo et al. (2024), this method is especially effective in understanding stakeholder behavior and systemic reform in digital transitions. Within this study, thematic analysis serves as the interpretive core, enabling the translation of fragmented literature into strategic insights for blockchain policy in agriculture.

2.2. Blockchain and the transformation of agricultural governance

The Ministry of Agriculture and Cooperatives plays a key role in shaping agricultural policy and advancing rural development in Thailand. Through its decentralized yet coordinated structure, MOAC oversees sectoral strategies spanning rice, livestock, irrigation, and innovation (MOAC, 2023). In recent years, MOAC has increasingly emphasized digital transformation to align agriculture with broader national goals of sustainability and market competitiveness. Its 5-Year Operational Plan (2023–2027) outlines five priorities: market-driven production, Agricultural Technology 4.0, the 3S (Safety, Security, Sustainability) model, Big Data integration, and sustainable agriculture inspired by the King's philosophy. Despite this vision, challenges remain, including digital literacy gaps, infrastructure constraints, and fragmented data systems. Blockchain has emerged as a promising tool to address these issues through decentralized, secure, and transparent systems that support real-time tracking, automated verification, and reliable data sharing. These features directly benefit policy areas such as traceability and subsidy distribution. Supporting evidence includes Zabala-Vargas et al. (2024), who found that blockchain-enabled smart contracts improved transparency in Southeast Asian rice supply chains; Mavilia and Pisani (2022), who observed enhanced trust and delivery efficiency in African cooperatives; and Daraghmi et al. (2024), who highlighted blockchain's role in agri-export data security. When combined with Internet of Things (IoT) and Big Data, blockchain fosters inclusive participation among farmers, regulators, and exporters. It thus operates not just as a data platform but as a strategic mechanism for institutional transformation.

2.3. Theoretical perspectives on public sector innovation and change

Integrating blockchain into Thailand's agricultural governance requires both organizational reform and behavioral change. Several theoretical frameworks inform this process. Lewin's (1947) three-step model views change as unfreezing norms, introducing new practices, and refreezing them into institutional routines (Prosci, 2024). Building on this, Kotter's (1995) eight-step model emphasizes urgency creation, vision-building, and cultural reinforcement — especially relevant for MOAC's cross-agency coordination (Sendros et al., 2022). At the individual level, the ADKAR (Awareness, Desire, Knowledge, Ability, Reinforcement) model provides a structured lens for managing digital transitions and retraining efforts (Ariestyadi & Taufik, 2020; Mudjisusatyo et al., 2024). On a systemic scale, Rogers' (2003) diffusion of innovations (DOI) theory explains adoption patterns, often driven by key influencers (Fujii, 2022; Clifton et al., 2023). Complementing the DOI, models like the technology acceptance model (TAM) (Davis, 1989) and unified theory of acceptance and use of technology (UTAUT) (Schretzlmaier et al., 2022) emphasize perceived usefulness and user trust as determinants of adoption. Case studies — from land registry reforms in Georgia and Estonia (Shang & Price, 2019) to cooperative platforms in Africa (Mavilia & Pisani, 2022) and agri-traceability in Southeast Asia (Daraghmi et al., 2024) — highlight blockchain's role in enhancing transparency and institutional trust, while also revealing persistent barriers such as infrastructure gaps and fragmented governance (SettleMint, 2024; Omanwa, 2023; Balcerzak et al., 2022). These insights underscore the importance of political commitment, regulatory clarity, and stakeholder engagement in ensuring effective blockchain adoption, offering strategic guidance for MOAC's policy implementation.

3. RESEARCH METHODOLOGY

3.1. Research design

This study adopts a qualitative meta-synthesis approach to examine the strategic role of blockchain in Thailand's agricultural governance. Meta-synthesis enables the integration of diverse qualitative findings to derive conceptual insights across complex, interdisciplinary domains. While other synthesis methods — such as systematic literature reviews (SLRs), meta-analyses, and bibliometric mapping — offer useful perspectives, they pose limitations for policy-oriented research in institutionally diverse contexts. SLRs may prioritize aggregation over interpretation; meta-analyses focus on quantitative precision, which is scarce in public-sector blockchain studies; and bibliometric mapping reveals publication trends but lacks depth in conceptual interlinkages.

In contrast, combining meta-synthesis with the PRISMA framework and the PICO model provides a context-sensitive and methodologically robust design. PRISMA promotes transparent study selection (Moher et al., 2009), while PICO offers conceptual clarity through structured inclusion criteria (Frandsen et al., 2020). Thematic analysis (see subsection 3.6) is used to extract policy-relevant patterns and cross-contextual themes. This integrated framework supports a coherent synthesis of blockchain-related research, drawing from 50 peer-reviewed studies published between 2014 and 2024, including academic theses, institutional reports, and empirical articles. The approach ensures a structured consolidation of insights to inform strategic policymaking for blockchain adoption by Thailand's MOAC.

3.2. Population and sample

The population for this meta-synthesis includes scholarly and institutional research addressing blockchain adoption in public sector contexts. Sources encompass graduate theses, peer-reviewed articles, conference proceedings, and research reports involving ministries and public agencies. Emphasizing digital governance and institutional reform, the study targeted literature from four academic databases — Google Scholar, ScienceDirect, IEEE Xplore, and SpringerLink — covering publications from 2014 to 2024. This period aligns with global growth in blockchain governance and Thailand's digital transformation agenda. Search terms, designed using PICO logic, included variations such as "Government blockchain usage" and "Public sector blockchain adoption" (see Appendix A), initially yielding 23,576 records. These underwent structured screening via the PRISMA framework, resulting in a final sample of 50 studies. Selected works met criteria for relevance, methodological rigor, and thematic alignment. The final set comprises both conceptual and empirical studies, supporting a balanced synthesis of policy frameworks, adoption dynamics, and technological design considerations.

3.3. Sample selection

Sample selection followed a structured protocol guided by PRISMA 2020 (Moher et al., 2009) to ensure methodological rigor and transparency. An initial pool of 23,576 records was retrieved using 12 PICO-based keyword combinations from four databases: Google Scholar, ScienceDirect, IEEE Xplore, and SpringerLink. The process involved four phases. First, during identification, duplicates and irrelevant studies — mainly those focused on cryptocurrency or private-sector uses — were removed, reducing the dataset to 1,084 records. Second, in the screening phase, titles and abstracts were reviewed, excluding 568 studies that lacked relevance to public-sector blockchain adoption. Third, in the eligibility stage, full-text reviews applied five inclusion criteria:

1) blockchain as a central focus;
2) relevance to public institutions;
3) discussion of adoption drivers or governance outcomes;
4) publication between 2014–2024;
5) English-language availability.

This yielded 568 eligible studies. Finally, in the inclusion phase, each study was quality appraised (see subsection 3.4), and 50 were selected based on methodological clarity and thematic alignment. This multi-step process ensured a conceptually rich and empirically grounded sample for synthesis. Detailed selection flows are provided in Figure B.1 and Table B.1 (see Appendix B).

3.4. Research instruments

To ensure consistency in data extraction and analysis, two primary instruments were used: a research quality assessment form and a research attribute recording form. The quality assessment form, adapted for meta-synthesis, applied a five-point Likert scale to evaluate 10 dimensions of research quality:

1) coherence between the title and objectives;
2) clarity of terminology;

3) relevance of literature;
4) sampling appropriateness;
5) methodological rigor;
6) suitability of analysis techniques;
7) clarity of findings;
8) accuracy of interpretations;
9) policy relevance;
10) overall scholarly contribution.

Each study was independently assessed for methodological soundness. Complementing this, the attribute recording form — based on frameworks by Rani et al. (2024), Haque et al. (2023), Mohamed (2023), Balcerzak et al. (2022), AL-Ashmori et al. (2022), Sousa (2023), and AlShamsi et al. (2022) — captured metadata, content, and methodological traits across 12 variables, such as publication year, blockchain type, application domain, stakeholder groups, and data sources (see Tables B.2 and B.3 in Appendix B). These tools enabled structured comparison, pattern recognition, and theme development, enhancing both transparency and analytical depth in line with best practices in qualitative synthesis.

3.5. Data collection

Data collection followed a structured, transparent process consistent with qualitative meta-synthesis principles and the PRISMA protocol. Relevant studies were retrieved from Google Scholar, ScienceDirect, IEEE Xplore, and SpringerLink using twelve predefined search terms reflecting blockchain use in public sector settings, such as "Government blockchain usage" and "Ministry blockchain adoption". Initial searches yielded over 23,000 records, refined through duplicate removal and screening (see subsection 3.3), resulting in a curated list for full-text review. The research quality assessment form and research attribute recording form (see subsection 3.4) guided the data extraction. Each article was independently coded by the lead researcher with input from two external meta-synthesis specialists to ensure inter-rater reliability. Discrepancies in scoring were resolved through discussion. Key variables — such as publication year, discipline, blockchain type, application domain, stakeholder category, research design, and data sources — were coded systematically. Microsoft Excel was used to organize the dataset through pivot tables and coded filters, supporting frequency analysis and structured comparison. This rigorous process ensured data consistency and laid the foundation for theme identification in the synthesis phase.

3.6. Data analysis

Data analysis followed a dual-method approach combining descriptive statistics and thematic analysis to achieve structural clarity and conceptual depth. Descriptive statistics summarized key study attributes using coded variables — such as *YEAR, MAJOR, NP, TBC, QBC, CBC, SBC, TR, RM*, and *SD* (see Table B.3) — analyzed in Excel via pivot tables to generate frequency distributions and cross-tabulations. These summaries provided an overview of publication trends, methodological patterns, and stakeholder profiles. Building on this, thematic analysis followed the six-phase process by Braun and Clarke (2006) and Nowell et al. (2017): 1) familiarization, 2) coding, 3) theme generation, 4) theme review, 5) definition, and 6) synthesis. While guided by predefined variables, coding remained open to emerging categories. Emphasis was placed on clarity, recurrence, and relevance to governance functions such as transparency, accountability, and interoperability. Themes were interpreted contextually rather than by frequency alone and aligned with the study's objectives, forming the conceptual structure for Section 4. This dual-method approach ensured both analytical rigor and interpretive depth in understanding blockchain adoption in institutional settings.

4. RESEARCH RESULTS

4.1. Descriptive characteristics of reviewed articles

This qualitative meta-synthesis examined 50 research articles published between 2014 and 2024, sourced from Google Scholar, ScienceDirect, IEEE Xplore, and SpringerLink. The selected studies focused on blockchain implementation in public sector contexts and were identified through purposive sampling informed by the PICO framework and screened using PRISMA guidelines. Coding was conducted based on predefined variables, including publication year, academic discipline, blockchain type, application domain, stakeholder engagement, and methodological design (see Table B.4). A summary of frequency distributions for these attributes is provided in Table B.5, with visualized representations in Figure B.2.

4.2. Thematic findings from meta-synthesis

Six major themes emerged from the thematic analysis, each representing a critical dimension of blockchain's application in public sector governance, particularly within agricultural systems. These themes reflect both recurring global patterns and Thailand-specific policy priorities, notably those of the MOAC. The thematic structure, detailed in Table B.6, was derived from variable interconnections and aligned with the analytical categories from the research attribute recording form.

- *Theme 1: Governance, trust, and transparency* — emphasizes blockchain's role in strengthening institutional integrity through enhanced transparency, corruption reduction, and improved auditability. Notably, security (100%), transparency (96%), and decentralization (88%) emerged as dominant attributes. Sub-themes include immutable transaction records for corruption prevention, decentralized decision-making frameworks, and trust-building between governments and citizens.
- *Theme 2: Operational efficiency and supply chain management* — highlights blockchain's ability to streamline agricultural logistics, reduce redundancies, and integrate with IoT for real-time tracking. Key linkages were found in supply chain monitoring (58%), smart system integration (94%), and economic application (100%), showcasing gains in both cost efficiency and traceability.
- *Theme 3: Data management and interoperability* — underscores the importance of reliable, decentralized data systems for cross-agency coordination. Secure data handling (100%) and transparency (96%) were highly referenced, with practical relevance for managing dynamic datasets such as subsidy distribution and weather forecasts.

- *Theme 4: Smart contracts and process automation* — explores blockchain's role in automating financial transactions and reducing administrative delays. Smart contracts were central to subsidy distribution (94%) and payment verification, contributing to improved speed and procedural accuracy.
- *Theme 5: Sustainability and environmental monitoring* — focuses on blockchain's utility in tracking carbon emissions, water usage, and environmental compliance. All articles addressed environmental data logging (100%), while 82% referenced resource management functions. Smart grids emerged as a blockchain-enabled solution for energy optimization in agriculture.
- *Theme 6: Stakeholder engagement and social inclusion* — illustrates how blockchain democratizes access to agricultural information, promoting equitable market participation and resource allocation. Public-private collaboration (100%) and participatory governance models were frequently emphasized, with benefits observed in pricing accuracy, weather forecasting, and inclusive policy feedback loops.

These six themes are synthesized visually in the thematic map presented in Figure B.3. Each theme corresponds to distinct blockchain functionalities and aligns with key governance domains in public agriculture, including transparency, efficiency, sustainability, and inclusion. The map illustrates directional interlinkages between technological mechanisms — such as smart contracts, decentralized ledgers, and real-time automation — and their institutional impacts. Notably, the theme of Governance, Trust, and Transparency demonstrates the broadest influence, intersecting with multiple outcome dimensions. By integrating these conceptual relationships, the thematic structure reveals blockchain's strategic potential as a policy enabler, reinforcing national objectives under Thailand's Digital Economy Strategy and advancing commitments to the SDGs.

5. DISCUSSION

5.1. Summary of key findings

This study conducted a qualitative meta-synthesis of 50 peer-reviewed international articles published between 2014 and 2024, focusing on blockchain applications within public sector governance. Guided by the PRISMA framework and PICO-based inclusion criteria, the analysis identified six strategic themes: 1) governance, trust, and transparency; 2) operational efficiency and supply chain management; 3) data management and integration; 4) smart contracts and automation; 5) sustainability and environmental impact; and 6) stakeholder engagement and social inclusion. Together, these themes form a conceptual framework that illustrates blockchain's transformative role in driving institutional reform and fostering public sector innovation. The findings reveal strong thematic recurrence across the literature, with particularly high emphasis on transparency (96%), decentralization (88%), and smart contracts (94%). Importantly, the thematic structure aligns with Thailand's national priorities in agricultural development and digital economic strategy, underscoring blockchain's relevance as a catalytic infrastructure for enhancing governance outcomes within the agricultural sector.

5.2. Discussion by Thematic Domain

5.2.1. Theme 1: Governance, trust, and transparency

As the conceptual foundation of blockchain-enabled transformation in the public sector, this theme highlights the central role of trust and transparency in driving institutional reform. Blockchain's immutability and decentralized verification mechanisms offer tamper-resistant audit trails, thereby reducing corruption and strengthening public confidence, critical conditions for catalyzing change within government systems (Sedlmeir et al., 2022). In alignment with Kotter's eight-step model, blockchain supports vision-setting and the creation of urgency (Sendros et al., 2022), as demonstrated in Georgia's land registry reforms (Shang & Price, 2019). ADKAR's emphasis on awareness and ability further addresses concerns over data security in fiscal governance, while Estonia's X-Road platform illustrates how secure architectures institutionalize systemic trust (Ariestyadi & Taufik, 2020; Aktsiaselts PricewaterhouseCoopers, 2019). In Thailand, decentralization strategies reflect the logic of DOI theory (Rogers, 2003), and adoption patterns among farmers align with TAM and UTAUT constructs (Davis, 1989; Schretzlmaier et al., 2022). As a thematic anchor, this domain underpins the effectiveness of all other blockchain-enabled functions.

5.2.2. Theme 2: Operational efficiency and supply chain management

This theme focuses on blockchain's contribution to enhancing efficiency in agricultural logistics, process automation, and redundancy reduction. These advances correspond to the "Change" phase in Lewin's model, where digital tools reshape workflows through real-time monitoring and systems integration (Prosci, 2024). Applications in IoT-driven agriculture (Dudczyk et al., 2024) align with SDG 2 on sustainable food production (Kouhizadeh et al., 2021), while Thailand's modernization agenda emphasizes streamlining administrative processes (Innovation Promotion Committee of the Secretariat of the House of Representatives, n.d.). Kotter's principle of coalition-building is essential for mobilizing cross-sectoral collaboration (Carreño, 2024), and blockchain's traceability capabilities enhance trust across supply chain stakeholders (Marchesi et al., 2022). However, the success of this theme is inherently linked to the trust architecture and data governance established in Themes 1 and 3.

5.2.3. Theme 3: Data management and integration

Serving as the informational backbone of institutional coordination, this theme explores blockchain's potential to create secure, interoperable, and auditable data infrastructures. These infrastructures are critical for aligning cross-agency operations and enabling real-time decision-making in areas such as subsidy distribution and climate-adaptive planning (Oruma et al., 2021). Empirical evidence from Estonia and Georgia highlights blockchain's capacity to deliver public accountability through transparent audit trails (Shang & Price, 2019). TAM and UTAUT emphasize the importance of user trust in system integrity, reinforcing the role of data reliability in technology adoption (Davis, 1989;

Schretzlmaier et al., 2022). In Thailand's case, Kotter's phased implementation strategy and workforce readiness programs play a pivotal role (Carreño, 2024). Ultimately, this theme serves as a structural enabler for broader institutional learning and digital transformation.

5.2.4. Theme 4: Smart contracts and automation

This theme underscores blockchain's capacity to institutionalize automated verification, reduce manual error, and enhance service reliability through smart contract applications. These capabilities are especially relevant to the disbursement of agricultural subsidies and contract farming schemes, aligning with Lewin's "Refreeze" stage, where new practices are embedded institutionally (Prosci, 2024). Kotter's emphasis on urgency supports reform in service responsiveness and accuracy (Sendros et al., 2022). According to UTAUT, users' behavioral intentions are closely tied to perceptions of system efficiency and dependability — advantages that blockchain demonstrably delivers through automation (Dudczyk et al., 2024). In Thailand, automation is positioned as a lever for advancing fiscal transparency and institutional responsiveness (Innovation Promotion Committee of the Secretariat of the House of Representatives, n.d.).

5.2.5. Theme 5: Sustainability and environmental impact

Blockchain's alignment with SDG 13 is reflected in its applications for carbon tracking, resource optimization, and real-time environmental compliance verification. Integrations with smart grids and water monitoring platforms enable transparent governance of ecological resources (Asgari & Nemati, 2022). Field-based evidence from Africa and India illustrates blockchain's effectiveness in reducing fraud and enhancing data reliability in sustainability initiatives (Mavilia & Pisani, 2022; SettleMint, 2024). DOI theory highlights the influence of sustainability champions in promoting adoption across sectors, while ADKAR identifies persistent gaps in awareness and ability, particularly in underserved rural contexts. These challenges signal the need for targeted digital literacy programs and cross-sectoral partnerships (Ariestyadi & Taufik, 2020). This theme illustrates blockchain's contribution to environmental governance, though its success depends on pre-existing institutional trust and robust data systems.

5.2.6. Theme 6: Stakeholder engagement and social inclusion

Blockchain's democratizing potential is most evident in its ability to broaden stakeholder participation, enhance access to agricultural data, and promote social inclusion. A 100% inclusion rate across the reviewed literature reflects blockchain's strength in supporting collaborative governance models. TAM and UTAUT highlight the critical role of trust in data accuracy for adoption, particularly among farmers reliant on digital tools for price discovery and resource planning (Davis, 1989; Schretzlmaier et al., 2022). Examples from Dubai and Africa demonstrate how locally adapted blockchain platforms can empower marginalized communities (Innovation Promotion Committee of the Secretariat of the House of Representatives, n.d.). In the Thai context, this theme directly links digital innovation with inclusive rural development, especially when reinforced by localized literacy initiatives and participatory policy frameworks.

5.3. Cross-thematic insights and strategic implications

Although analyzed as distinct domains, the six themes identified in this study reveal interlinked strategic insights. Trust, transparency, and data interoperability — central to Themes 1 and 3 — emerged as foundational elements underlying all blockchain functions. These factors reappeared across areas like supply chain management, stakeholder participation, and environmental oversight, highlighting their role in fostering institutional reliability and accountability. Likewise, automation and operational efficiency — emphasized in Themes 2 and 4 — extend beyond technical execution, shaping discourse around fiscal responsibility and agile public service delivery. These overlaps suggest that blockchain's value in agricultural governance lies not in isolated applications but in its capacity to generate systemic coherence. This integrative role enables the technology to enhance institutional integrity, streamline operations, and expand inclusive participation. Therefore, strategic initiatives — such as decentralized traceability, smart subsidies, and sustainability-linked data systems — should be designed with a multi-dimensional perspective, aligning digital tools with institutional reform and SDG-based policies. Achieving this vision requires coordination among agencies, technology partners, and users. In this regard, blockchain functions not just as a tool but as a strategic infrastructure for transforming governance within and beyond the agricultural sector.

Beyond the Thai context, these strategic insights offer relevant guidance for other developing economies facing similar challenges in agricultural governance, such as fragmented data infrastructures, inefficient subsidy distribution, and low stakeholder trust. For instance, Vietnam and Indonesia, both undergoing digital agricultural reforms, can adapt the proposed model to enhance traceability and automate financial transactions in decentralized rural systems. In Sub-Saharan Africa, where public trust and institutional coherence remain critical issues, the emphasis on transparency and data integrity through blockchain aligns with broader governance reforms. By contextualizing blockchain adoption within national digital strategies and SDG priorities, the framework developed in this study can serve as a replicable roadmap for emerging economies seeking to enhance governance, efficiency, and inclusiveness in their agricultural sectors.

6. CONCLUSION

This study presents a comprehensive meta-synthesis of 50 internationally published articles examining blockchain adoption in public sector governance, with specific implications for Thailand's MOAC. Through systematic thematic analysis, six core themes were identified — governance and trust, operational efficiency, data management, automation, sustainability, and stakeholder inclusion — each representing a strategic avenue through which blockchain can enhance institutional performance, public accountability, and service delivery.

The findings emphasize that blockchain should not be regarded merely as a technological innovation but as a policy-enabling infrastructure for institutional transformation and digital reform. Its integration is closely aligned with Thailand's 20-Year Digital Economy Strategy and supports multiple SDGs, including SDG 2 (Zero Hunger), SDG 9 (Industry, Innovation, and Infrastructure), and SDG 16 (Peace, Justice, and Strong Institutions). Core principles such as transparency, data security, automation, and cross-sector collaboration consistently emerged as foundational to successful implementation.

Building on these insights, it is recommended that MOAC prioritize targeted pilot programs in key areas such as agricultural product traceability, automated subsidy disbursement, and integrated supply chain management. These applications leverage blockchain's strengths in auditability, real-time monitoring, and smart contract execution. Public-private partnerships should be strategically mobilized to co-develop platforms, bridge capacity gaps, and strengthen shared infrastructure. Equally important, stakeholder engagement mechanisms must be embedded to ensure alignment with the needs of farmers, local administrators, and system users.

Future research should extend beyond technical feasibility to examine governance readiness, institutional capacity, and behavioral adoption. Empirical investigations into interoperability with legacy systems, digital literacy levels, and adaptive regulatory frameworks will deepen understanding of implementation challenges. Comparative studies with countries possessing similar agricultural and governance characteristics — such as Vietnam, Indonesia, or Colombia — can provide additional insights into scalable blockchain strategies suitable for emerging economies.

Despite blockchain's potential, several persistent challenges and limitations remain. High implementation costs, fragmented regulations, and limited technical expertise continue to hinder large-scale adoption. In rural areas, digital infrastructure gaps and varying levels of user readiness — particularly among farmers and local bureaucracies — further delay deployment and reduce policy impact. These constraints can heighten institutional uncertainty and stall reform momentum. As such, blockchain adoption should be gradual, adaptive, and context-aware. Public-private partnerships may help mitigate risk, while targeted capacity-building and modular pilot programs offer practical entry points. Although this study employed a rigorous meta-synthesis, reliance on secondary data may overlook emerging trends and real-time developments. Future research should adopt longitudinal and field-based methods to explore implementation dynamics, institutional learning, and behavioral change over time. Tools like policy sandboxing and experimental governance may also aid in testing blockchain interventions under realistic conditions, contributing to more responsive and scalable policy design.

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APPENDIX A

Table A.1. PICO framework for research selection

Parameter	*Inclusion criteria*
Population	Keywords: Government, ministry, public sector, state
Intervention	None (No specific intervention applied)
Comparison	None (No comparison required)
Outcome	Blockchain usage, blockchain adoption, blockchain implementation

Source: The methodology and data set for the current research are based on Junchairussamee et al. (2025).

To ensure replicability and methodological transparency, this study employed a structured search strategy guided by predefined inclusion and exclusion criteria.

Search strategy: Academic literature was retrieved from Google Scholar, ScienceDirect, IEEE Xplore, and SpringerLink using targeted keywords, Boolean operators, and controlled vocabulary. The search emphasized blockchain applications in public sector governance, with a specific focus on agriculture.

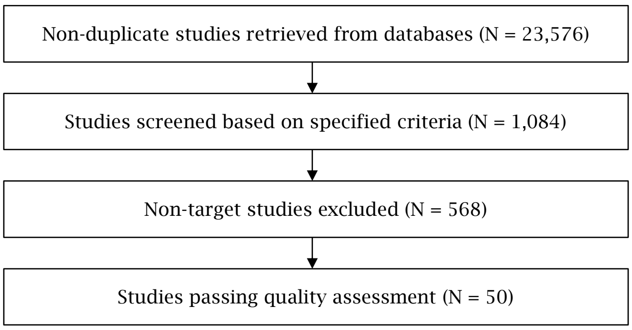
Inclusion criteria: Eligible studies included peer-reviewed journal articles, graduate theses, and institutional reports published between 2014 and 2024. Studies had to explicitly address blockchain adoption within public agricultural governance and cover related themes such as policy implementation, transparency, data security, and supply chain traceability, ensuring a comprehensive perspective on blockchain's contribution to governance efficiency and sustainability.

Exclusion criteria: Excluded were studies limited to private-sector blockchain use without public governance integration, as well as those lacking empirical rigor or methodological clarity. Opinion pieces, duplicates, and articles unrelated to blockchain-enabled governance were also removed. This approach ensured that only high-quality, substantively relevant sources informed the analysis.

A total of 23,576 records were initially identified. After duplicate removal and preliminary screening, 1,084 articles remained. These were evaluated in four PRISMA stages — identification, screening, eligibility, and inclusion — based on clearly defined inclusion and exclusion criteria. Following full-text review and quality appraisal using a 10-dimension rubric, 50 high-quality sources were selected for final synthesis. This structured, transparent approach enhances methodological replicability and ensures that the meta-synthesis is grounded in empirically robust and thematically aligned literature.

APPENDIX B

Figure B.1. Summary of research selection following PRISMA guidelines



Source: The methodology and data set for the current research are based on Junchairussamee et al. (2025).

Table B.1. Number of research studies retrieved and approved

Electronic database	*Number of studies retrieved*	*Number of studies selected*	*Number of studies approved*
Google Scholar	17,800	8	3
ScienceDirect	315	74	7
IEEE Xplore	2,230	394	33
SpringerLink	3,231	92	7
Total	23,576	568	50

Source: The methodology and data set for the current research are based on Junchairussamee et al. (2025).

Table B.2. Research quality assessment form

Aspects of research quality	*Score*				
	0	*1*	*2*	*3*	*4*
Coherence among the research title, issues, and objectives					
Clarity of definitions for specific terminology					
Currency of literature and relevant studies					
Appropriateness of sample selection					
Research design					
Choice of statistical methods/techniques for data analysis					
Clarity in presenting data analysis results					
Accuracy in research conclusions					
Clarity in discussing research findings and providing recommendations					
Overall quality of the research					

Source: The methodology and data set for the current research are based on Junchairussamee et al. (2025).

Table B.3. Research attribute recording form

Variable	*Code*	*Coded sub-variables*
Identification of the article	*ID*	Amount of 50 articles
Published year	*YEAR*	Last two digits of the year published
Faculty/field of study	*MAJOR*	1 = Faculty of Education 2 = Faculty of Sports Science 3 = Faculty of Nursing 4 = Faculty of Science and Technology 5 = Faculty of Humanities and Social Sciences 6 = Faculty of Agriculture 7 = Faculty of Technology 8 = Faculty of Business Administration and Accounting 9 = Faculty of Education 10 = Faculty of Management Science 11 = Faculty of Engineering 12 = Other/not specified
Number of pages	*NP*	Number of pages
Type of blockchain	*TBC*	1 = Public blockchain 2 = Private blockchain 3 = Hybrid blockchain
Blockchain attributes	*QBC*	1 = Decentralization 2 = Transparency 3 = Safety 4 = Flexibility 5 = Efficiency 6 = Sustainability
Blockchain applications	*UBC*	1 = Financial transactions 2 = Data storage 3 = Transport tracking 4 = Supply chain management
Context of blockchain system usage	*CBC*	1= Social context 2 = Economic context 3 = Technological context
Stakeholders in blockchain system usage	*SBC*	1 = Government agencies 2 = Private sector 3 = Public sector
Research design	*TR*	1 = Quantitative research 2 = Qualitative research
Research methodology	*RM*	1 = Documentary study 2 = Exploratory study 3 = Experimental study
Data source	*SD*	1 = Academic documents 2 = Empirical data 3 = Experiential data

Source: The methodology and data set for the current research are based on Junchairussamee et al. (2025).

Table B.4. Coding screening table (Part 1)

ID	*Name*	*YEAR*	*MAJOR*	*NP*	*TBC*	*QBC*	*UBC*	*CBC*	*SBC*	*TR*	*RM*	*SD*
1	Islam et al. (2023)	23	4,12	29	1	1,2,3,4,5	2,4,5	1,2,3	1,2,3	2	1,2,3	1
2	Vangipuram et al. (2022)	22	4,11	19	2	1,2,3,4,5,6	2,5	1,2,3	1,2,3	1	1,2,3	2
3	Farooq et al. (2022)	22	10,11	18	2,3	1,2,3,4,5	2,5	1,2,3	1,2,3	2	1,2,3	1
4	Khalil et al. (2022)	22	4	15	1,2	1,2,3,4,5	2,5	1,2,3	1,2,3	1	1,2,3	1,2
5	Ali et al. (2021)	20	10,12	15	1,2,3	1,2,3,4,5,6	1,2,3,4,5	1,2,3	1,2,3	2	1,2	1
6	Kumar et al. (2020)	20	4,10,11	20	2	1,2,3,4,5,6	2,4,5	1,2,3	1,2,3	2	1,2,3	2,3
7	Gohar et al. (2022)	20	4,12	20	1	1,2,3,4,5,6	2,4,5	1,2,3	1,2,3	2	1,2,3	1,2,3
8	Butun and Österberg (2021)	21	4,11	14	1	1,2,3,4,5,6	1,2,3,4,5	1,2,3	1,2,3	1,2	1,2,3	1,2,3
9	Elisa, Yang, Chao, Naik, et al. (2023)	23	4,7,12	15	3	1,2,3,4,5,6	2,5	1,2,3	1,2,3	2	1,2,3	1,2,3
10	Touloupou et al. (2022)	22	7	12	1,2,3	1,2,3,4,5,6	1,2,5	1,2,3	1,2,3	2	1,2,3	1,2
11	Sunny et al. (2022)	22	4,8,10	20	2	1,2,3,4,5,6	1,2,3,4,5	1,2,3	1,2,3	1	1,2	2,3
12	Chukwu and Garg (2020)	20	7	20	1,2	1,2,3,4,5,6	2,5	1,2,3	1,2,3	2	1,2,3	1,2
13	Akkaoui et al. (2022)	22	7	20	2,3	2,3,4,5,6	2,5	1,2,3	1,2,3	2	1,2,3	1,2
14	Jiang et al. (2022)	22	4,7	20	1,2,3	3,4,5,6	1,2,4,5	1,2,3	1,2,3	1,2	1,2,3	1,2,3
15	Gatica-Neira et al. (2023)	23	8,11	14	3	3,4,5,6	2,5	1,2,3	1,2,3	1	1,2,3	1,2
16	Oruma et al. (2021)	21	4,11	20	3	2,3,4,5,6	2,5	1,2,3	1,2,3	2	1,2,3	1,2,3
17	Mircea et al. (2022)	22	4	19	1,2	1,2,3,4,5,6	2,4,5	1,2,3	1,2,3	2	1,2,3	1,2
18	Marchesi et al. (2022)	22	4	20	2	1,2,3,4,5,6	2,4,5	1,2,3	1,2,3	2	1,2,3	1,3
19	Sifah et al. (2020)	20	4,11,12	12	1	1,2,3,4,5,6	2,5	1,2,3	1,2	2	1,2,3	1,2
20	Abou Jaoude and Saade (2019)	19	12	19	1,2	1,2,3,4,5,6	1,2,4,5	1,2,3	1,2,3	2	1,2,3	1,2
21	Alladi et al. (2019)	19	11,12	14	1,2,3	1,2,3,4,5,6	1,2,4,5	1,2,3	1,2,3	1,2	1,2,3	1,2
22	Bodkhe et al. (2020)	20	11	20	1,2	1,2,3,4,5,6	2,4,5	1,2,3	1,2	1,2	1,2,3	1,2
23	Cagigas et al. (2021)	21	12	22	1,2	1,2,3,4,5,6	2,4,5	1,2,3	1,2,3	2	1,2,3	1,2
24	Ordóñez et al. (2023)	23	11,12	18	1.2	1,2,3,4,5,6	1,2,4,5	1,2,3	1,2,3	2	1,2,3	1,2
25	Yang et al. (2022)	22	13	11	1,2,3	1,2,3,4,5,6	2,5	1,2,3	1,2	2	1,2,3	1,2
26	Dudczyk et al. (2024)	24	11	17	1,2,3	1,2,3,4,5,6	1,2,3,4,5	1,2,3	1,2,3	2	1,2,3	1,2
27	Agarwal et al. (2022)	22	4,11	19	1,2,3	1,2,3,4,5,6	1,2,3,5	1,2,3	1,2,3	1,2	1,2,3	1,2
28	Haga and Omote (2022)	22	11	13	2	1,2,3,4,5,6	1,2,3,4,5	1,2,3	1,2	2	1,2,3	1
29	Musamih et al. (2021)	21	4,11	17	1	1,2,3,4,5,6	1,2,3,5	1,2,3	1,2	2	1,2,3	1,2
30	Chang and Wang (2023)	23	7	14	1,2	1,2,3,4,5,6	1,2,5	1,2,3	1,2,3	1,2	1,2,3	1
31	Al-Shaibani et al. (2020)	20	7	15	3	1,2,3,4,5,6	1,2,5	1,2,3	1,2	1,2	1,2,3	1,2
32	Abugabah et al. (2020)	20	4	18	2	1,2,3,4,5,6	1,2,5	1,2,3	1,2,3	2	1,2,3	1,2
33	Lytras and Șerban (2020)	20	4	12	2	1,2,3,4,5,6	2,5	1,2,3	1,2,3	1,2	1,2,3	1,2
34	Nour et al. (2022)	22	7,11	15	2,1,3	1,2,3,4,5,6	1,2,3,5	1,2,3	1,2,3	1,2	1,2,3	1,2

Table B.4. Coding screening table (Part 2)

ID	*Name*	*YEAR*	*MAJOR*	*NP*	*TBC*	*QBC*	*UBC*	*CBC*	*SBC*	*TR*	*RM*	*SD*
35	Salman et al. (2019)	19	4	13	1,2	1,2,3,4,5,6	2,5	1,2,3	1,2,3	2	1,2,3	1,2
36	Stojanović et al. (2022)	22	4	20	1,2	1,2,3,4,5,6	1,2,5	1,2,3	1,2	2	1,2,3	1
37	Alam et al. (2022)	20	11	15	3	1,2,3,4,5,6	1,2,5	1,2,3	1,2,3	1,2	1,2,3	1
38	Nookhao and Kiattisin (2023)	23	11	17	2	2,3,5,6	5	1,2,3	1,2,3	1	1,2,3	1,2
39	Bennacer et al. (2022)	22	4	15	1,2	1,2,3,4,5	2,5	1,2,3	1,2	2	1,2,3	1,2
40	Addison et al. (2024)	24	4	15	2	2,3,5,6	2,5	1,2,3	1,2,3	1	1,2,3	1,2
41	Ungson and Soorapanth (2022)	22	8	12	1,2,3	1,2,3,4,5	1,4,5	1,2,3	1,2,3	2	1,2,3	1
42	Weigl et al. (2023)	23	12	12	3	1,2,3,4,5,6	5	1,2,3	1,2,3	2	1,2,3	1,2
43	Martínez-Castañeda and Feijóo (2023)	23	7	15	1,2,3	1,2,3,4,5,6	4,5	1,2,3	1,2,3	1,2	1,2,3	1,2
44	Rejeb et al. (2022)	21	4,8,11	32	1,2,3	1,2,3,4,5,6	4,5	1,2,3	1,2,3	2	1,2,3	1
45	Sarnacchiaro et al. (2024)	24	12	33	2,3	2,3,5	**5**	1,2,3	1,2,3	1,2	2,3	1,2
46	Elisa, Yang, Chao, and Cao (2023)	18	4	15	1	1,2,3,4,5,6	2,5	1,2,3	1,2	2	1,2,3	1
47	Zhu et al. (2024)	24	4	15	1,2,3	1,2,3,4,5,6	5	1,2,3	1,2	2	1,2	1
48	Azevedo et al. (2023)	23	12	23	2	1,2,3,5,6	4,5	1,2,3	1,2,3	1	1,2	1,2
49	Jung (2018)	18	12	12	1,2	1,2,3,5,6	5	1,2,3	1,2,3	2	1,2	1
50	Saripalli (2021)	21	12	8	1,2	1,2,3,5,6	5	1,2,3	1,2	2	1,2	1

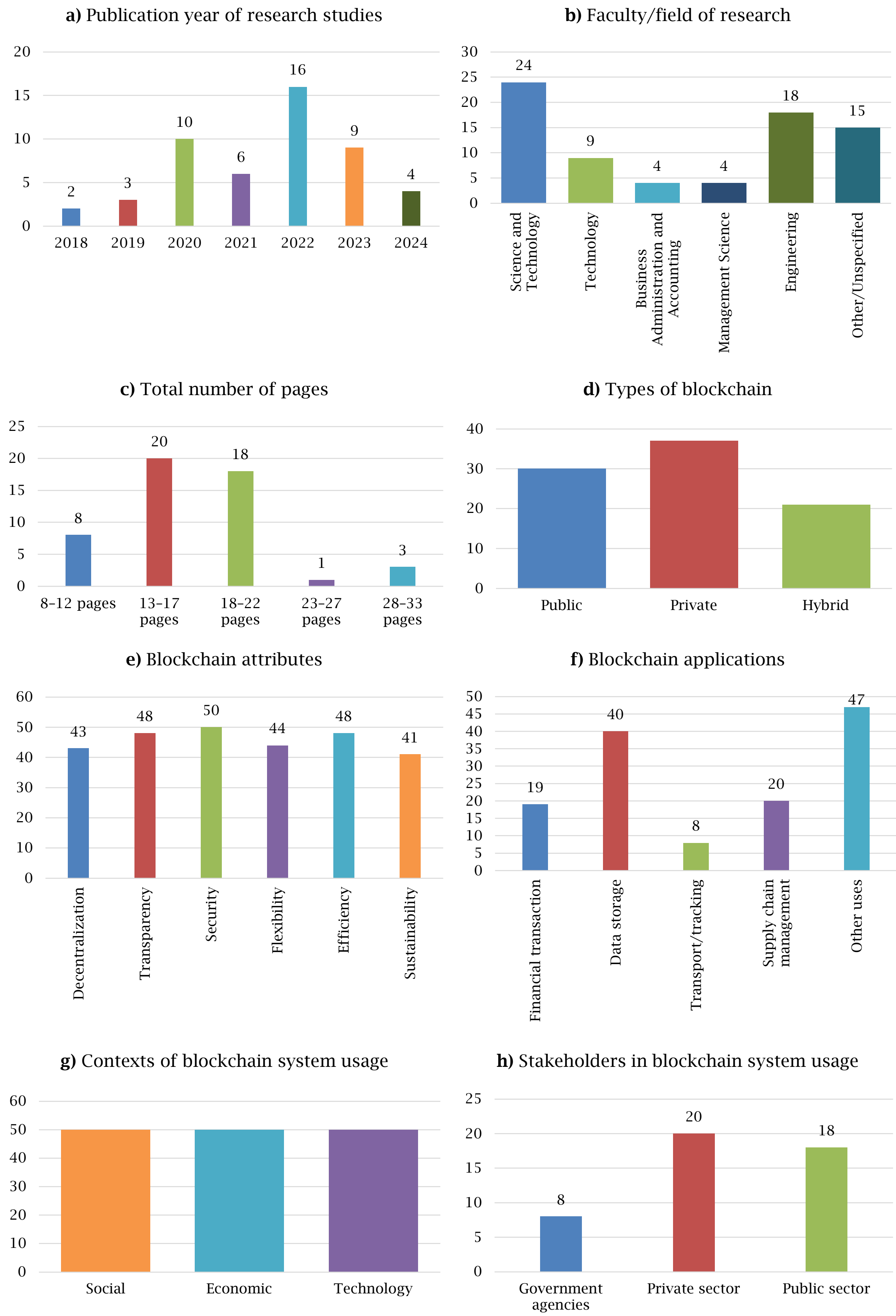
Source: The methodology and data set for the current research are based on Junchairussamee et al. (2025).

Table B.5. Pivot table of major and sub-variables

Major and sub-variables	*Frequency*
YEAR	
2018	2
2019	3
2020	10
2021	6
2022	16
2023	9
2024	4
MAJOR	
Science and Technology	24
Technology	9
Business Administration and Accounting	4
Management Science	4
Engineering	18
Other/Unspecified	15
NP	
8–12 pages	8
13–17 pages	20
18–22 pages	18
23–27 pages	1
28–33 pages	3
TBC	
Public blockchain	30
Private blockchain	37
Hybrid blockchain	21
QBC	
Decentralization	43
Transparency	48
Security	50
Flexibility	44
Efficiency	48
Sustainability	41
UBC	
Financial transactions	19
Data storage	40
Transport tracking	8
Supply chain management	20
Other uses	47
CBC	
Social context	50
Economic context	50
Technological context	50
SBC	
Government agencies	50
Private sector	50
Public sector	39
TR	
Quantitative research	19
Qualitative research	43
RM	
Document study	49
Survey study	50
Experimental study	44
SD	
Academic documents	47
Empirical data	36
Experiential data	8

Source: The methodology and data set for the current research are based on Junchairussamee et al. (2025).

Figure B.2. Major and sub-variables in a bar chart



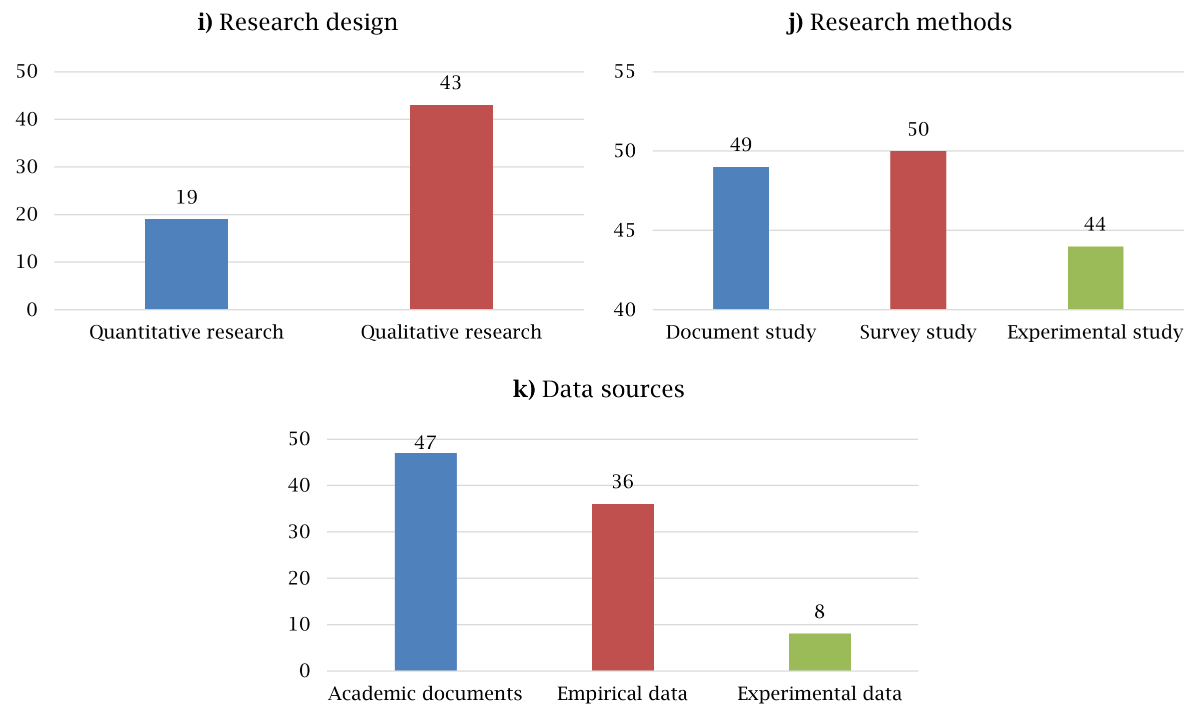
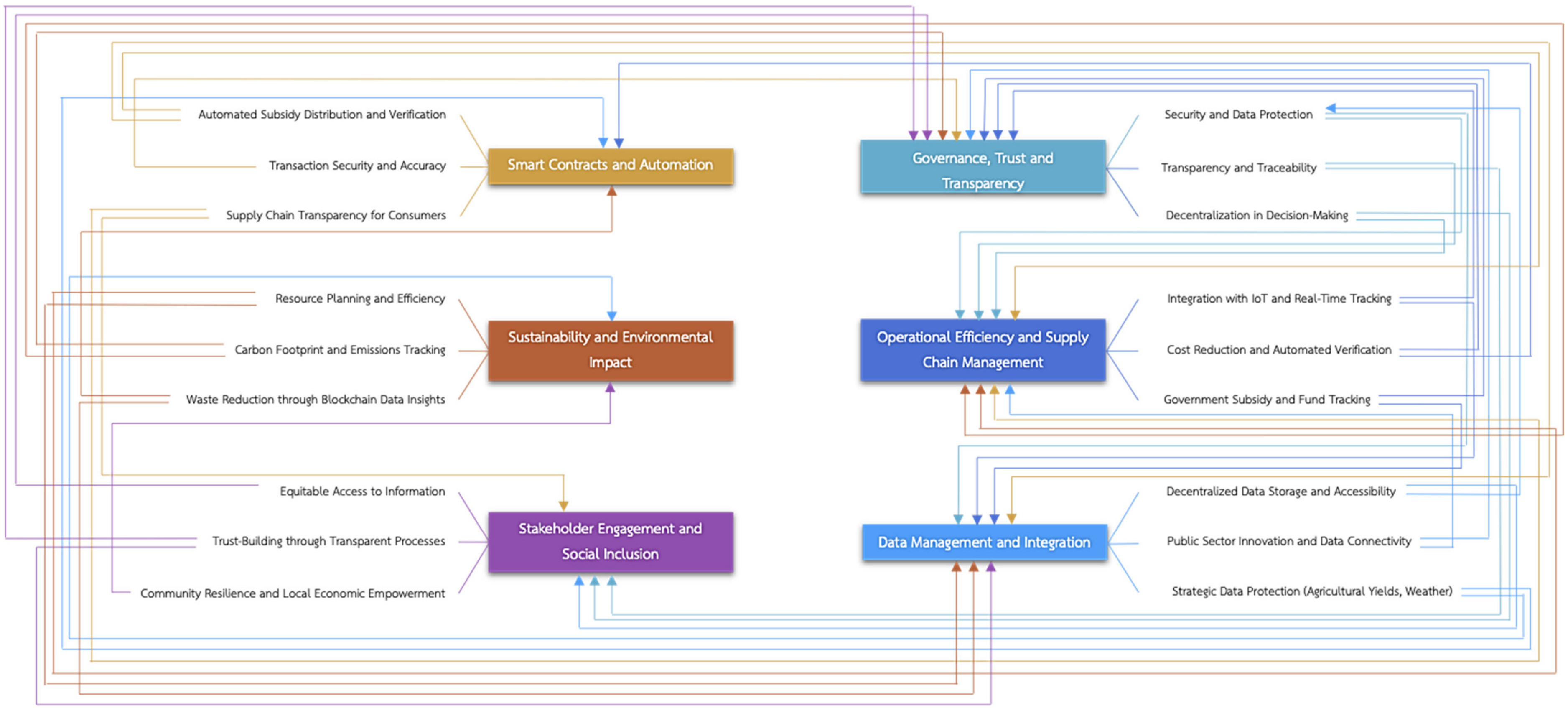

i) Research design
50
40
30
20
10
0
19
43
Quantitative research
Qualitative research
j) Research methods
55
50
45
40
49
50
44
Document study
Survey study
Experimental study
k) Data sources
50
40
30
20
10
0
47
36
8
Academic documents
Empirical data
Experimental data

Table B.6. Structure of main and sub-themes derived from connected variables

Main/Sub-themes	*Source and connected variables*	*Frequency from pivot table (articles)*	*Description*
1. Governance, trust, and transparency	Blockchain features emphasize transparency and decentralization	• Security: 50 • Transparency: 48 • Efficiency: 48 • Decentralization: 44 • Flexibility: 43	Transparent governance helps reduce corruption and builds trust in government agencies by using blockchain's traceability features. Decentralization fosters fairness and efficiency.
1.1. Anti-corruption	Blockchain traceability and transparency features	• Transparency: 48	Blockchain increases transparency, reducing opportunities for corruption in government processes.
1.2. Decentralized decision-making	Type of blockchain for decentralization	• Private blockchain: 37 • Public blockchain: 30	Decentralization reduces power concentration, promoting fairness and inclusion.
1.3. Building trust between government agencies and the public	Blockchain features promoting transparency, security, and efficiency foster stakeholder trust	• Security: 50 • Transparency: 48 • Efficiency: 48	Blockchain creates confidence in processes and data across relevant sectors.
2. Operational efficiency and supply chain management	Blockchain applications in logistics and production systems	• Economic context: 50 • Other (IoT, innovation, digital governance, smart grid): 47 • Data storage: 40 • Supply chain management: 29 • Transportation tracking: 8	Efficient supply chain management using blockchain reduces complex processes, ensures systematic data storage, and enhances transparency and speed in tracking the origins of agricultural products.
2.1. Efficient supply chain management	Blockchain application in supply chain management	• Supply chain management: 29	Blockchain enables end-to-end tracking of agricultural products, promoting transparency and reducing losses in the supply chain.
2.2. Reducing operational costs	Blockchain application in data storage for auditing and tracking goods	• Other (IoT, innovation, digital governance, smart grid): 47 • Data storage: 40 • Transportation tracking: 8	Reduces redundancy in documentation and improves data management systems, lowering operational costs, e.g., minimizing time for transaction verification and approval.
3. Data management and integration	Blockchain features for secure data storage and integration, as well as efficient blockchain data storage applications	• Security: 50 • Transparency: 48 • Efficiency: 48 • Data storage: 40	Blockchain minimizes redundancy, protects data privacy, and enhances data integration across agencies.
3.1. Data privacy	Protecting data privacy through types, features, and applications of blockchain for data storage	• Security: 50 • Data storage: 40 • Private blockchain: 37	In agriculture, protecting farmers' private data and the government's strategic data (e.g., weather and harvest data) is essential.
3.2. Data integration across agencies	Data storage without intermediaries using decentralized data storage technology	• Decentralization: 43	Blockchain reduces data redundancy and promotes efficient inter-agency data linking and coordination.
4. Smart contracts and automation	Blockchain application and features via smart contracts for automated agreements	• Security: 50 • Transparency: 48 • Efficiency: 48 • Other (IoT, innovation, digital governance, smart grid): 47 • Data storage: 40	Smart contracts reduce human errors in transactions, and automation minimizes operational time for ministries, e.g., in subsidy allocation.
4.1. Automatic agreement creation	Automatic agreement creation and/or smart contracts	• Other (IoT, innovation, digital governance, smart grid): 47	Smart contracts increase accuracy and speed in transactions, e.g., paying farmers upon meeting set conditions.
4.2. Automated payment and subsidy distribution	Automated payment systems	• Other (IoT, innovation, digital governance, smart grid): 47	Blockchain automates payments and subsidies, reducing human error.
5. Sustainability and environmental impact	Using blockchain features to monitor efficient resource use for sustainability	• Technological context: 50 • Social context: 50 • Efficiency: 48 • Sustainability: 41	Blockchain supports efficient resource management, e.g., water and energy, promoting sustainability and reducing environmental impact.
5.1. Carbon and energy management	Carbon and energy management	• Technological context: 50	Blockchain assists in monitoring and tracking carbon emissions, allowing the agricultural sector to plan for sustainability goals.
5.2. Sustainable resource management	Sustainable resource management	• Sustainability: 41	Blockchain promotes efficient resource use, e.g., water use, and disaster management.
6. Stakeholder engagement and social inclusion	Promoting equal data access between farmers and various agencies	• Government agencies: 50 • Private sector: 50 • Social context: 50 • Technological context: 50 • Public sector: 39	Blockchain fosters cooperation between the government, private sector, and public in economic advancement, especially by involving farmers in decision-making.
6.1. Farmer participation	Engagement across all sectors	• Government agencies: 50 • Private sector: 50 • Public sector: 39	Blockchain allows farmers to participate in policy and resource allocation decisions, e.g., crop pricing.
6.2. Public-private collaboration	Collaboration between the public and private sectors through system transparency	• Government agencies: 50 • Private sector: 50 • Transparency: 48	Blockchain strengthens public-private collaboration through transparency and trust.
6.3. Promoting equal data access	System transparency and traceability ensure systematic and effective access	• Transparency: 48 • Efficiency: 48 • Decentralization: 43 articles	Blockchain disseminates key information, such as product pricing and weather data, ensuring widespread and easy access.

Figure B.3. Thematic map



APPENDIX C

This appendix provides a list of 50 studies that were systematically selected and analyzed as part of the meta-synthesis, conducted in accordance with the PRISMA 2020 guidelines. These studies served as the primary data sources for context coding and the development of the conceptual framework in this research.

Table C.1. Reference list from target information from Meta-synthesis/PRISMA (Part 1)

Authors/Year	*Title*	*Journal/Source*
Abou Jaoude and Saade (2019)	Blockchain applications — Usage in different domains	*IEEE Access*
Abugabah et al. (2020)	Decentralized telemedicine framework for a smart healthcare ecosystem	*IEEE Access*
Addison et al. (2024)	Exploring the impact of agricultural digitalization on smallholder farmers' livelihoods in Ghana	*Heliyon*
Agarwal et al. (2022)	Blockchain technology for secure supply chain management: A comprehensive review	*IEEE Access*
Akkaoui et al. (2022)	A taxonomy and lessons learned from blockchain adoption within the Internet of Energy paradigm	*IEEE Access*
Alam et al. (2022)	A blockchain-based land title management system for Bangladesh	*Journal of King Saud University — Computer and Information Sciences*
Ali et al. (2021)	A comparative study: Blockchain technology utilization benefits, challenges, and functionalities	*IEEE Access*
Alladi et al. (2019)	Blockchain applications for industry 4.0 and industrial IoT: A review	*IEEE Access*
Al-Shaibani et al. (2020)	Consortium blockchain-based decentralized stock exchange platform	*IEEE Access*
Azevedo et al. (2023)	Supply chain traceability using blockchain	*Operations Management Research*
Bennacer et al. (2022)	Design and implementation of a new blockchain-based digital health passport: A Moroccan case study	*Informatics in Medicine Unlocked*
Bodkhe et al. (2020)	Blockchain for Industry 4.0: A comprehensive review	*IEEE Access*
Butun and Österberg (2021)	A review of distributed access control for blockchain systems towards securing the Internet of Things	*IEEE Access*
Cagigas et al. (2021)	Blockchain for public services: A systematic literature review	*IEEE Access*
Chang and Wang (2023)	Blockchain-enabled fintech innovation: A case of reengineering stock trading services	*IEEE Access*
Chukwu and Garg (2020)	A systematic review of blockchain in healthcare: Frameworks, prototypes, and implementations	*IEEE Access*
Dudczyk et al. (2024)	Blockchain technology for global supply chain management: A survey of applications, challenges, opportunities, and implications	*IEEE Access*
Elisa, Yang, Chao, Naik, et al. (2023)	A secure and privacy-preserving e-government framework using blockchain and artificial immunity	*IEEE Access*
Elisa, Yang, Chao, and Cao (2023)	A framework of blockchain-based secure and privacy-preserving e-government system	*Wireless Networks*
Farooq et al. (2022)	Consortium framework using blockchain for asthma healthcare in pandemics	*Sensors*
Gatica-Neira et al. (2023)	Adoption of cybersecurity in the Chilean manufacturing sector: A first analytical proposal	*IEEE Access*
Gohar et al. (2022)	A patient-centric healthcare framework reference architecture for better semantic interoperability based on blockchain, cloud, and IoT	*IEEE Access*
Haga and Omote (2022)	Blockchain-based autonomous notarization system using national eID card	*IEEE Access*
Islam et al. (2023)	Distributed ledger technology-based integrated healthcare solution for Bangladesh	*IEEE Access*
Jiang et al. (2022)	A tertiary review on blockchain and sustainability with focus on Sustainable Development Goals	*IEEE Access*
Jung (2018)	Blockchain government — A next form of infrastructure for the twenty-first century	*Journal of Open Innovation: Technology, Market, and Complexity*
Khalil et al. (2022)	*DSCOT: An NFT-based blockchain architecture for the authentication of IoT-enabled smart devices in smart cities*	arXiv
Kumar et al. (2020)	A novel smart healthcare design, simulation, and implementation using healthcare 4.0 processes	*IEEE Access*
Lytras and Şerban (2020)	E-government insights to smart cities research: European Union (EU) study and the role of regulations	*IEEE Access*
Marchesi et al. (2022)	Automatic generation of Ethereum-based smart contracts for agri-food traceability system	*IEEE Access*
Martínez-Castañeda and Feijóo (2023)	Use of blockchain in the agri-food value chain: State of the art in Spain and some lessons from the perspective of public support	*Telecommunications Policy*
Mircea et al. (2022)	Analysis of the impact of blockchain and Internet of Things (BIoT) on public procurement	*IEEE Access*
Musamih et al. (2021)	Blockchain-based solution for the administration of controlled medication	*IEEE Access*
Nookhao and Kiattisin (2023)	Achieving a successful e-government: Determinants of behavioral intention from Thai citizens' perspective	*Heliyon*
Nour et al. (2022)	Review of blockchain potential applications in the electricity sector and challenges for large-scale adoption	*IEEE Access*
Ordóñez et al. (2023)	Blockchain in agriculture: A PESTELS analysis	*IEEE Access*

Table C.1. Reference list from target information from Meta-synthesis/PRISMA (Part 2)

Authors/Year	***Title***	***Journal/Source***
Oruma et al. (2021)	Agriculture 4.0: An implementation framework for food security attainment in Nigeria's post-COVID-19 era	*IEEE Access*
Rejeb et al. (2022)	Blockchain technology in the smart city: A bibliometric review	*Quality & Quantity*
Salman et al. (2019)	Security services using blockchains: A state of the art survey	*IEEE Communications Surveys & Tutorials*
Saripalli (2021)	Transforming government banking by leveraging the potential of blockchain technology	*Journal of Banking and Financial Technology*
Sarnacchiaro et al. (2024)	The role of blockchain technology in the tourism industry: Analyzing the factors affecting its adoption	*Quality & Quantity*
Sifah et al. (2020)	BEMPAS: A decentralized employee performance assessment system based on blockchain for smart city governance	*IEEE Access*
Stojanović et al. (2022)	Smart contract application for managing land administration system transactions	*IEEE Access*
Sunny et al. (2022)	A systematic review of blockchain applications	*IEEE Access*
Touloupou et al. (2022)	A systematic literature review toward a blockchain benchmarking framework	*IEEE Access*
Ungson and Soorapanth (2022)	The ASEAN blockchain roadmap	*Asia and the Global Economy*
Vangipuram et al. (2022)	G-DaM: A distributed data storage with blockchain framework for management of groundwater quality data	*Sensors*
Weigl et al. (2023)	The construction of self-sovereign identity: Extending the interpretive flexibility of technology towards institutions	*Government Information Quarterly*
Yang et al. (2022)	Blockchain technology application maturity assessment model for digital government public service projects	*International Journal of Crowd Science*
Zhu et al. (2024)	The governance technology for blockchain systems: A survey	*Frontiers of Computer Science*