Acta Informatica Pragensia
2027, Volume 16, Issue 1, Forthcoming article
https://doi.org/10.18267/j.aip.315

PRAGUE UNIVERSITY OF ECONOMICS AND BUSINESS

Review Open Access

Blockchain Applications and Governance Implications in the Public Sector: A Literature Review

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Editorial Record

First submission received:
September 19, 2025

Revisions received:
January 5, 2026
March 19, 2026

Accepted for publication:
March 23, 2026

Academic Editor:
Miloslav Hub
University of Pardubice, Czech Republic

This article was accepted for publication by the Academic Editor upon evaluation of the reviewers' comments.

How to cite this article:
Nuryanti, L., Ayuningtyas, F., Sumunaringrum, M. D. W., Ruswendi, W., Srimoeljanto, A., Sutejo, A., Susanto, T., & Nurmayni, R. (2027). Blockchain Applications and Governance Implications in the Public Sector: A Literature Review. *Acta Informatica Pragensia*, 16(1), Forthcoming article. https://doi.org/10.18267/j.aip.315

Abstract

Background: Blockchain is increasingly recognized as a transformative enabler of e-governance, offering capabilities to enhance transparency, efficiency, security, and citizen trust in public-sector administration. However, widespread adoption remains constrained by persistent technical, regulatory, and socio-institutional challenges, particularly the absence of coherent governance frameworks across jurisdictions.

Objective: This study aims to systematically map the evolution of blockchain applications in e-governance, identify dominant research themes and collaboration patterns, and highlight governance-related challenges that inform future policy and research agenda.

Methods: A systematic analysis was performed on 196 publications indexed in Scopus, covering the period 2019–2025, selected to capture the rapid growth of blockchain-related e-governance research. The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) protocol guided the screening process, while a bibliometric analysis using Biblioshiny examined publication trends, country contributions, collaboration networks, and thematic clusters.

Results: The analysis shows that research output peaked in 2022 and subsequently shifted toward more domain-specific and applied applications, including e-voting, land administration, taxation, intellectual property, and academic credentialing. China, India, and the United States emerged as the most active contributors, though with markedly different collaboration patterns and governance approaches. Key challenges identified across the literature include interoperability limitations, scalability and cybersecurity risks, fragmented regulatory environments, and uneven institutional capacity. These findings highlight the critical role of governance frameworks in enabling sustainable and interoperable blockchain adoption in public-sector contexts.

Conclusion: Blockchain represents both a technological and institutional innovation with significant potential to reshape e-governance. Its sustainable adoption requires interdisciplinary collaboration, coherent governance frameworks, and alignment between technological capabilities and regulatory-institutional readiness. Ultimately, blockchain's transformative value lies in bridging innovation with practical governance to enhance transparency, accountability, and citizen confidence in public services.

Index Terms

Blockchain; E-governance; Public sector applications; Bibliometric analysis; Governance frameworks.

1 INTRODUCTION

The global acceleration of digital transformation in government has not eliminated the persistent and multidimensional challenges facing effective public service delivery.

Globally, public administrations are expected to fulfill core functions spanning regulation, social protection, education, and economic development (Wamba et al., 2024), yet many countries continue to struggle with serious deficiencies in service quality (Grima et al., 2021). At the forefront of these deficiencies are three interconnected governance challenges: transparency, accountability, and public trust. The absence of verifiable and tamper-resistant records enables corruption and erodes citizen confidence in public institutions (Warkentin & Orgeron, 2020). Data and information management remain weak across many jurisdictions (Lafioune et al., 2023), leaving governments exposed to privacy vulnerabilities and systemic data breaches (Strebinger & Treiblmaier, 2024). Beyond individual agencies, these challenges compound into a broader interoperability deficit. E-governance initiatives, while increasingly ambitious, have not yet overcome the structural barriers to cross-agency coordination and inclusive citizen participation (Crusoe et al., 2024).

These governance challenges are compounded by a more specific structural problem that motivates the present study. Many existing digital systems in the public sector operate in isolation within fragmented administrative structures, resulting in limited data interoperability and weak inter-agency coordination (Xia & Zhao, 2025). Insufficient data integrity controls, privacy weaknesses, and inadequate information security measures further widen the gap between technological advancement and institutional capacity (Saeed et al., 2025). Digital procurement systems, for instance, still lack unified governance frameworks capable of enabling secure, verifiable, and efficient interactions between governments and suppliers. These unresolved deficiencies signal the need for a fundamentally different technological approach, one capable of simultaneously enhancing trust, transparency, and interoperability across institutional boundaries.

Blockchain technology has emerged as a leading candidate to address these structural deficiencies. Blockchain refers to a decentralized digital record-keeping system in which data are maintained across multiple nodes, reducing reliance on centralized authorities while enhancing data integrity and resilience (Balatska et al., 2024). Through the use of cryptographic validation and peer-to-peer networking, blockchain enables the creation of linked records that are resistant to unauthorized modification and independently verifiable by network participants (Puneeth & Parthasarathy, 2024). Emerging technologies like blockchain provide innovative solutions in data management and public services. The global blockchain industry is expected to reach a market size of $67.4 billion by 2026, with a projected compound annual growth rate of 85.9% from 2022 to 2030 (Wamba et al., 2024). Blockchain's main advantages lie in its transparency, security, and immutability, which together make it highly suited for contexts where trust is critical (Tan et al., 2022). These attributes align closely with government goals to improve public services, governance, and institutional performance through various policies, laws, and regulations (Warkentin & Orgeron, 2020). Recognized as one of the most disruptive and transformative technologies, blockchain is driving profound changes in the actions of individuals, organizations, and governments, with far-reaching impacts (Wamba et al., 2024).

Despite the growing body of literature on blockchain in the public sector, critical gaps persist in its scholarly mapping. Existing bibliometric studies have examined blockchain across adjacent domains, including decentralized finance (Kumar et al., 2025), environmental sustainability (Bhatt & Emdad, 2025), and accounting (Parra-Domínguez et al., 2025), yet none systematically addresses its intersection with public-sector governance. Studies on e-governance have explored digital transformation trends in relation to broader policy frameworks such as the Sustainable Development Goals (Khairul Islam et al., 2025), but without isolating blockchain as a distinct analytical lens. The most proximate prior work mapped global publication trends in blockchain-enabled e-governance (Nuryanti et al., 2025). It did not, however, extend its analysis to governance implications, thematic evolution, or the socio-institutional conditions shaping adoption across jurisdictions. The field therefore lacks a comprehensive synthesis that integrates bibliometric evidence with governance-oriented interpretation. Such a synthesis would identify not only where research has concentrated, but also which institutional, regulatory, and interoperability challenges remain systematically unaddressed across different governance contexts.

This study offers the first comprehensive bibliometric mapping of blockchain research in e-governance covering the period 2019–2025, integrating quantitative publication trends with qualitative interpretive analysis. Unlike prior works that focus mainly on technical aspects or single-domain applications, this research adopts a holistic perspective that connects technological developments with governance, institutional, and policy implications. By systematically identifying thematic clusters, collaboration patterns, and unresolved challenges, the study reveals several critical gaps in the existing literature. This combined bibliometric–interpretive approach advances scholarly

understanding of blockchain-enabled e-governance and provides actionable insights to support policymakers and practitioners in designing more effective and contextually relevant digital transformation strategies. The analysis is structured around three research questions addressing publication dynamics and collaboration patterns, applications and key challenges, and research gaps with future opportunities for blockchain adoption in e-governance.

1.1 Literature review

1.1.1 E-governance and emerging blockchain integration

E-governance[1] refers to the use of information and communication technology (ICT) to improve public service delivery, transparency, decision-making, and citizen participation in governance processes (Troitiño et al., 2024). By leveraging ICT, governments are able to enhance administrative efficiency, combat corruption, and ensure more equitable access to public services. The primary goal of e-governance is to establish a governance system that is efficient, transparent, accountable, and inclusive. This involves the digitalization of administrative processes to streamline services, build public trust, and enable secure and equitable distribution of services to all citizens. E-governance forms the foundation for digital transformation within the public sector, and it plays a critical role in replacing manual administrative procedures with automated, digital solutions.

However, realizing the full potential of e-governance increasingly requires the integration of innovative technologies such as blockchain. Beyond cryptocurrencies, it supports decentralized decision-making in both public and corporate settings (Polcumpally et al., 2024). Its core features-decentralization, immutability, and auditability-reduce reliance on intermediaries and protect records from tampering, thereby enhancing public trust (Y. Lu, 2019). Blockchain also transforms traditional top-down governance into a decentralized model, providing greater decision-making autonomy at multiple organizational levels. These developments indicate that blockchain has become a critical enabler for realizing the full potential of e-governance. Integration of blockchain into e-governance initiatives has been observed in various countries, enhancing transparency, operational efficiency, data security, and openness, and supporting the development of a more efficient, inclusive, and trustworthy public service ecosystem (Aoun et al., 2021).

1.1.2 Blockchain for public sector governance

Blockchain has gained increasing attention in the public sector due to its potential to transform how governments manage data, deliver services, and maintain trust in institutional processes. Blockchain's core attributes of decentralization, immutability, and auditability collectively create secure, tamper-proof administrative environments that enhance accountability, improve efficiency, and strengthen trust (J. Singh et al., 2025). Blockchain applications cover several sectors such as digital currency and payments, land registration, identity management, notary services, supply chain traceability, healthcare, education and many more (Tan et al., 2022). Increasingly, blockchain is viewed not merely as a technological innovation but as a governance-enabling infrastructure that supports transparency, inclusiveness, and trust in public administration.

Despite these benefits, several structural and institutional limitations continue to hinder large-scale adoption of blockchain in the public sector. Challenges in adopting blockchain technology in e-governance are diverse, involving technological, organizational, and environmental factors, and require careful consideration of privacy and accountability due to the decentralized and immutable nature of the technology (Rodriguez Muller et al., 2025).

1.1.3 Theoretical perspectives on public sector blockchain adoption

The use of two complementary theoretical lenses is necessary, institutional theory and sociotechnical systems theory. Institutional theory examines how organizations are influenced by regulatory, normative, and cognitive-cultural pressures within their institutional environment (Ma & Ma, 2025). Applying institutional theory to blockchain adoption in the public sector highlights that implementation outcomes are driven not only by technological

[1] This study adopts "e-governance" as the primary term, encompassing the broader use of information and communication technology to enhance transparency, accountability, citizen participation, and institutional decision-making in the public sector. The narrower term "e-government" is retained where it reflects the terminology used in cited sources or refers specifically to digital government systems (Troitiño et al., 2024).

capabilities but also by regulatory legitimacy, governance norms, and entrenched bureaucratic practices. Sociotechnical systems theory posits that optimal organizational performance depends on the joint optimization of interdependent social and technical subsystems (Munch et al., 2022). Applying this lens, successful blockchain implementation requires alignment between technical design choices and social factors, including organizational culture, stakeholder acceptance, and environmental regulations. Therefore, blockchain implementation is not solely a technical endeavor but requires simultaneous attention to the human, organizational, and institutional dimensions.

1.1.4 Key constructs for blockchain-enabled e-governance

Defining core constructs is essential for understanding blockchain governance. A governance framework refers to the formal and informal institutional arrangements, rules, and processes for decision-making and accountability. These processes encompass on-chain mechanisms such as context protocols and off-chain structures including regulatory policies (Zhou et al., 2025). Institutional readiness reflects the capacity of public organizations to adopt new technologies, including organizational culture, technological infrastructure, human capital, and legal frameworks. This readiness is essential for achieving interoperability, defined as the ability of multiple systems to operate seamlessly across technical, semantic, organizational, and legal levels (Vijaya et al., 2025). In the context of public sector blockchain, the balance between institutional readiness and interoperability is crucial for generating public value that extends beyond economic efficiency to include transparency, accountability, and citizen trust. These interrelated constructs provide an analytical framework for interpreting the bibliometric findings in the following section.

2 RESEARCH METHODS

This study applies a bibliometric method to analysis and systematically examine the scientific literature on blockchain in e-governance, providing a structured assessment of publication patterns, thematic development, and research trends. This method enables the tracing of publication trends, identification of leading contributors, and mapping of collaboration networks. It also highlights the boundaries of the field and identifies areas where research remains limited (Tandon et al., 2021). To ensure a transparent and consistent article selection process, the preferred reporting items for systematic reviews and meta-analyses (PRISMA) protocol was followed. The PRISMA flow diagram illustrates the process of literature identification, screening, eligibility assessment, and inclusion, thereby ensuring a rigorous and replicable selection process (Tooki & Popoola, 2025). These analyses provide insights into dominant research priorities, the structure of thematic clusters, and emerging directions for future studies in blockchain and e-governance.

2.1 Research questions

To ensure analytical clarity and focus, the investigation is structured around guiding research questions that explore publication trends, thematic evolution, and future research directions. The key questions are presented below:

- **RQ1.** What are the publication trends, dominant countries, collaboration patterns, and main thematic areas, in blockchain research for e-governance?
- **RQ2.** What are the applications, and key challenges identified in blockchain implementation for the public sector?
- **RQ3.** What research gaps and future opportunities exist to advance blockchain adoption in e-governance?

2.2 Study identification

The first step of the review process was study identification. The literature search was conducted on 31 October 2025 using the following native Scopus syntax:

```
TITLE-ABS-KEY ( ( "blockchain" OR "distributed ledger" ) AND ( "public sector"
OR "public administration" OR "public service" ) AND ( "government" OR
"governance" OR "e-government" OR "governmental" ) AND ( "applications" OR "use
cases" OR "implementation" ) )
```

The search strategy combined three conceptual blocks: (1) blockchain terms ("blockchain," "distributed ledger"), (2) public sector governance terms ("e-governance," "e-government," "digital government," "public sector," "public administration," "governance"), and (3) application and focused terms ("application," "use case," "implementation"). The inclusion of application-focused studies aims to ensure that the dataset emphasizes empirical research and real-world implementations. This approach provides a more targeted and practically relevant analysis that aligns with the objective of examining governance implications and sector-specific adoption patterns.

The retrieved records were exported in CSV format containing full bibliographic information, including titles, authors, affiliations, abstracts, keywords, and cited references. The complete dataset is publicly available as described in Data Availability Statement. Data preprocessing and standardization were performed prior to analysis using OpenRefine. Author names, keywords, country affiliations, and institutional data were combined using nearest neighbor clustering and followed by manual verification to enhance accuracy. Author names were standardized by combining spelling variants and initials, keywords were normalized with respect to synonyms and singular plurals, and country and institutional names were harmonized to address naming inconsistencies. A full-billing approach was applied to country- and institution-level analyses, where each affiliation received equal credit for multi-author publications. Thematic analysis utilized shared word networks with a co-word threshold (freq=5), using the Louvain clustering algorithm and association strength normalization. Country collaboration networks were visualized using an automatic layout algorithm.

2.3 Study selection

Scopus was chosen as the primary database for several reasons. Scopus has a comprehensive database and is well-suited for bibliometric analysis due to its broad coverage, covering a wide range of publishers and disciplines (Atique et al., 2024). Furthermore, Scopus provides comprehensive metadata quality and export functions essential for bibliometric analysis using Biblioshiny/Bibliometrix, as well as indexing various conference proceedings and book chapters, which are highly relevant for emerging technology research due to their numerous significant contributions.

The 2019–2025 timeframe was selected because an initial Scopus search indicated that research on blockchain in e-governance began to increase significantly in 2019, coinciding with the rise in government pilot projects and global policy implementation. 2019 marked a crucial point when blockchain shifted from discussions primarily focused on cryptocurrencies to broader public sector applications. Key policy developments occurred, such as China's national blockchain strategy and the European Union's blockchain governance initiatives, including the European blockchain services infrastructure (EBSI) (Tan et al., 2023). Limiting the end year to 2025 ensures inclusion of the most recent published studies while maintaining a manageable and coherent dataset for analysis.

Table 1. *Inclusion criteria.*

ID	Inclusion Criteria
IC1	The article discusses blockchain, distributed ledger technology, and government, and their role in improving transparency, efficiency, and public service delivery in the public sector.
IC2	The article focuses on blockchain based models/architecture, governance frameworks, smart contracts, interoperability, or digital transformation in public administration.
IC3	Studies discussing the implementation, use cases, or applications of blockchain in government contexts.
IC4	The source of the article is published between 2019–2025.
IC5	The article is written in English.

Building on the search strategy described above, the 250 initially retrieved records were screened according to the PRISMA two-step eligibility criteria detailed in Table 1 and Table 2. The selection was carried out by reviewing the titles, abstracts and keywords of all identified papers, followed by verifying whether they met the established inclusion and exclusion requirements. These criteria focus the dataset on empirical studies and real-world implementations. This selection enables a more targeted and practically relevant analysis aligned with the objective of examining governance implications and sector-specific adoption patterns.

Table 2. *Exclusion criteria.*

ID	Exclusion Criteria
EC1	Articles that focus solely on the technical or cryptographic aspects of blockchain without relevance to governance, public services, or administrative applications.
EC2	Studies emphasizing financial, banking, or cryptocurrency use cases (e.g., Bitcoin, DeFi, NFTs) rather than public sector implementations.
EC3	Publications that discuss blockchain applications in the private or commercial sector with no linkage to government or public administration
EC4	The article is outside the 2019–2025 publication range.
EC5	Duplicate entries, incomplete bibliographic information, or articles not written in English.

2.4 PRISMA workflow

In the PRISMA workflow, defining the study period is essential to ensure the selection of literature aligns with the most relevant and up-to-date research trends. The 2019–2025 period captures the most recent surge in blockchain e-governance research, which began to accelerate in 2019. Preliminary Scopus checks showed a significant rise in publications during this time, aligning with increased pilot projects and policy adoption. The inclusion criteria were refined to prioritize studies explicitly addressing blockchain applications and implementation in the public sector, rather than articles discussing blockchain technology in a broader or more general conceptual context. This targeted approach resulted in a more focused dataset that better aligns with the research objectives of examining practical governance implications and sector-specific adoption.

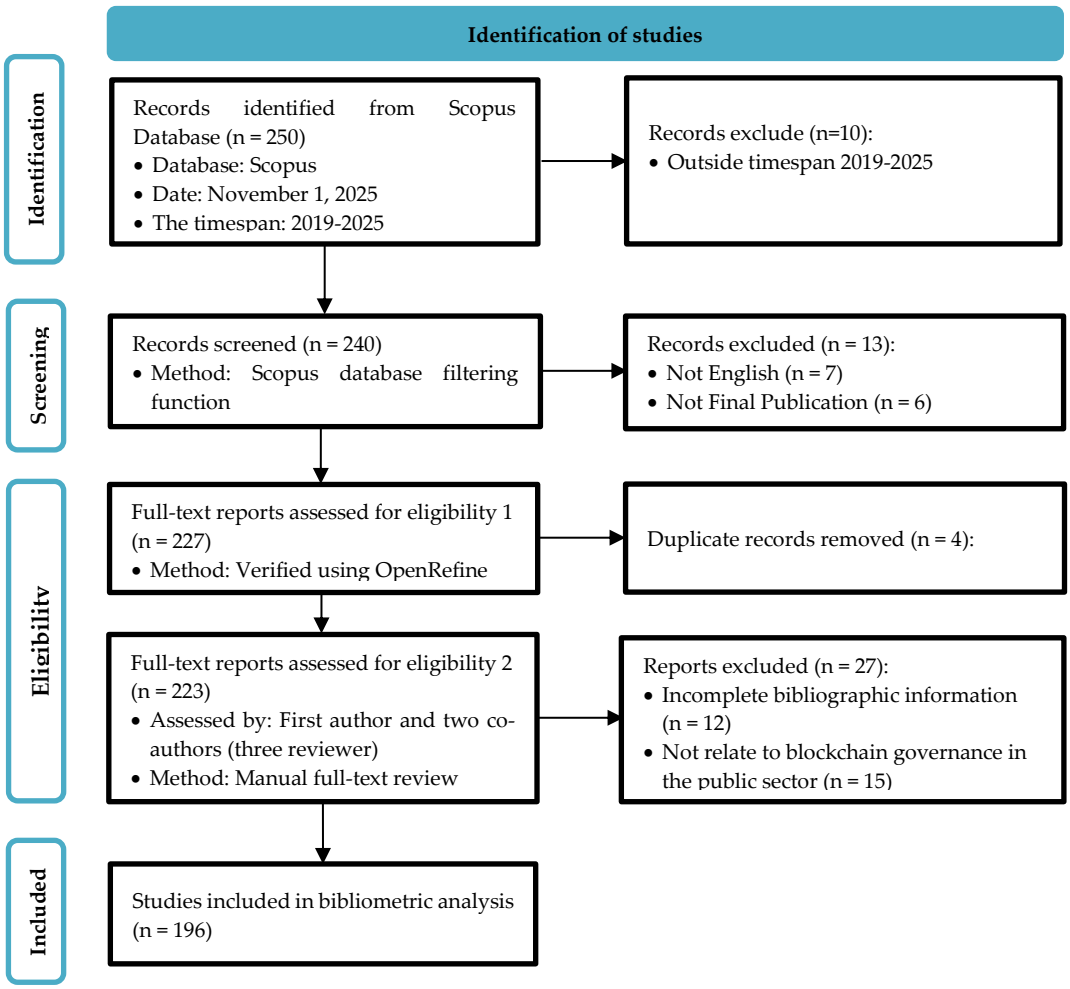

Figure 1. *PRISMA workflow for systematic literature identification, screening, and inclusion.*

Of the 250 initially retrieved records, 23 were excluded during Scopus database filtering as they did not meet the predefined search criteria, leaving 227 records for further assessment. Duplicate detection was performed using OpenRefine, identifying and removing 4 duplicate entries. The remaining 223 full-text reports were assessed for eligibility by three independent reviewers through manual review. The result of the exclusion is 27 records that did not meet the established inclusion requirements. This process produces a final dataset of 196 articles for bibliometric analysis, and Figure 1 presents the four-step workflow employed for data collection and analysis.

3 RESULTS AND DISCUSSION

The analysis was conducted to systematically map the intellectual structure and evolution of research on blockchain in e-governance. This approach enables a comprehensive examination of publication growth, authorship patterns, source distribution, and thematic development within the field. By capturing both productivity and impact indicators, the analysis provides a robust foundation for identifying emerging research directions and knowledge gaps. As summarized in Table 3, the annual publication output and average citation rates demonstrate a pronounced exponential growth, indicating a rapidly expanding and increasingly influential research domain.

Table 3. *Main data information of the bibliometric (2019–2025).*

Description	Result
Documents	196
Annual Growth Rate %	21.71
Timespan	2019–2025
Sources (Books, Journals, etc.)	103
Author's Keywords	531
Keywords Plus	946
Author	688
Single-authored docs	0

Document Types	Result
Article	74
Book	3
Book Chapter	35
Conference Paper	69
Editorial	2
Note	1
Review	12

3.1 RQ1: Evolution of scientific publications

To examine the trajectory of scholarly interest in blockchain for e-governance, this study first analyzed the volume and growth pattern of publications over the 2019–2025 period. Figure 2 presents the annual distribution of publications on blockchain technology in e-governance for the public sector. The number of publications increased steadily from 12 in 2019 to a peak of 37 in 2022, followed by a slight decline in 2023–2024 and a renewed growth reaching 39 publications in 2025. This pattern reflects an initial surge of exploratory studies leading to a period of consolidation and renewed interest in recent years.

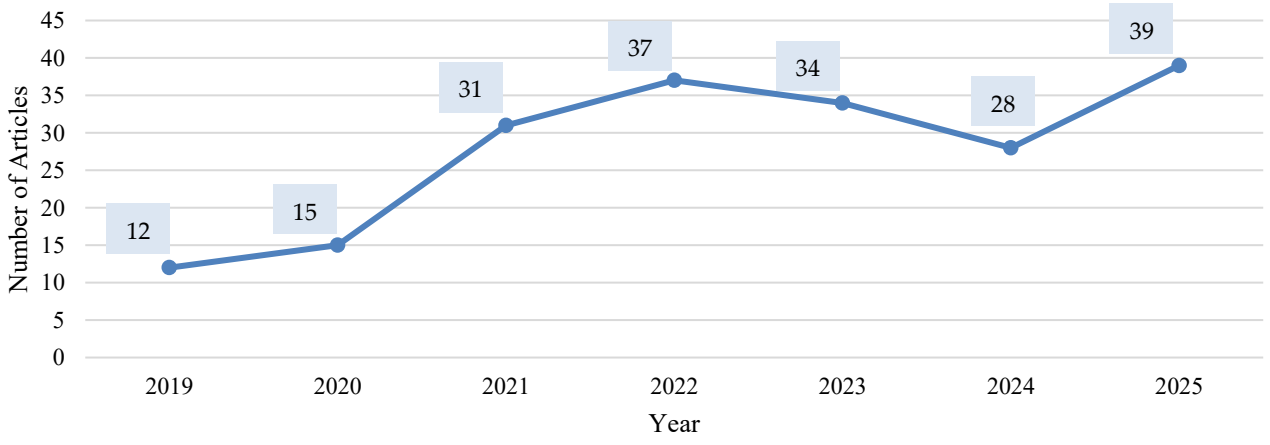

Figure 2. *Article distribution of publications on blockchain in e-governance (2019–2025).*

The graphs fluctuated after 2022, but the trend remains significantly higher than in the initial period, underscoring the sustained relevance of blockchain in the digital transformation of the public sector. The publication surge from 2019 to 2022 aligns with global policy initiatives, as major economies including China and the European Union that began formalizing blockchain strategies and launching large-scale pilot programs in public administration. The peak in 2022 also coincided with increased interest in digital ecosystems and secure government infrastructure, particularly after the disruption caused by the COVID-19 pandemic accelerated the digital transformation agenda worldwide.

The decline after 2022 may reflect three factors: (1) a maturing stage where research shifted from exploratory conceptualization to sector-specific implementation studies; (2) competition from emerging technologies, as artificial intelligence and large language models attracted increasing scholarly attention; and (3) regulatory consolidation, as governments transitioned from policy experimentation to establishing clearer legal frameworks for blockchain adoption. A rebound in 2025 suggests renewed momentum, potentially driven by successful pilot implementations and growing institutional confidence in blockchain's long-term potential for enhancing transparency and efficiency in public governance. The specific regulatory developments and country-level policy contexts that shape these trends are examined in detail in Section 3.1.3 (Evolution of Global Research Participation).

3.1.1 Thematic evolution with temporal overlay

Science mapping is a bibliometric method that creates visual representations of the structure and progression of an academic field by mapping the connections between publications, researchers, or topics of study (Rajendran et al., 2024). Thematic evolution maps display how clusters of related keywords evolve, merge, or decline across different time periods, thereby illustrating the intellectual continuity and transformation.

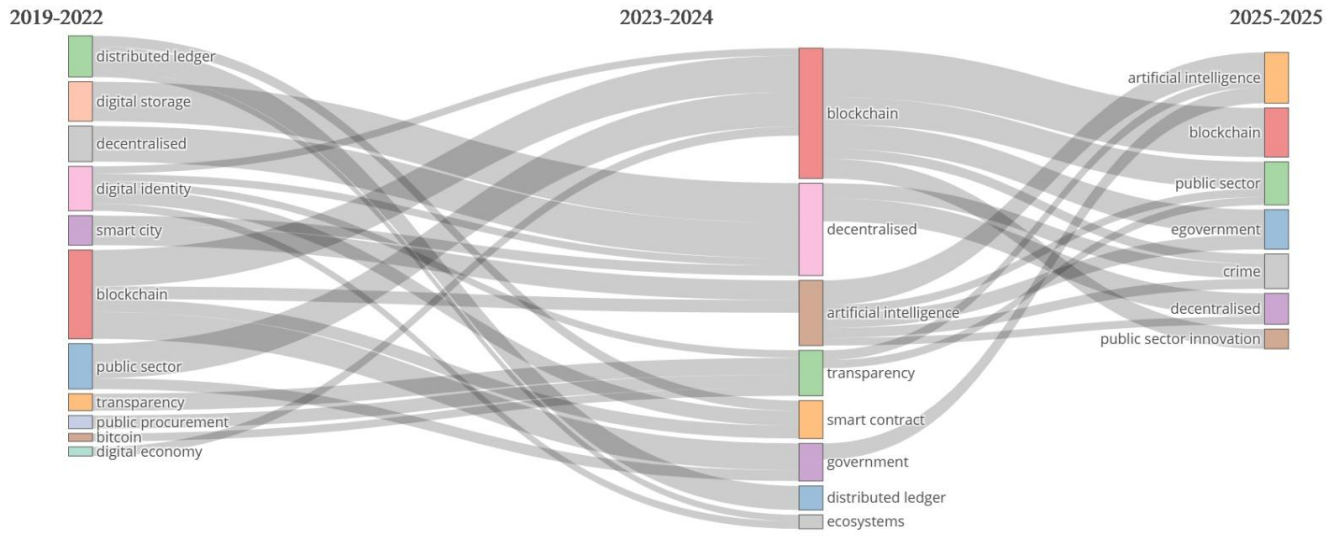

Figure 3. *Thematic evolution with temporal overlay across three periods.*

Figure 3 represents the thematic evolution with a temporal overlay, illustrating dominant research themes in blockchain-enabled e-governance emerge, persist, converge, and specialize across consecutive time periods. Unlike a static thematic map, this visualization tracks longitudinal keyword transitions, allowing direct observation of how early broad concepts evolve into more application-driven and governance-oriented themes over time.

To empirically examine the post-2022 maturity effect, the dataset was time-sliced into three periods (2019–2022, 2023–2024, and 2025). As summarized in Table 4, early studies emphasized broad conceptual themes, whereas later periods demonstrate increasing thematic integration, application specificity, and governance relevance, thereby supporting the interpretation of a maturation phase rather than a decline in scholarly interest.

Table 4. *Comparative analysis of thematic evolution across three periods.*

Period	Dominant Themes	Thematic Characteristics	Evolutionary Interpretation
2019-2022	Blockchain, decentralised, digital identity, digital storage, smart city, public sector, transparency	Broad and exploratory themes focusing on foundational blockchain concepts, governance potential, and digital transformation in public services	**Exploratory phase** characterized by conceptual framing and technology positioning
2023-2024	Blockchain, decentralised, artificial intelligence, transparency, smart contract, government, distributed ledger	Transition toward integrative and application-oriented research, combining blockchain with AI, smart contracts, and governance mechanisms	**Consolidation phase**, where research narrows toward system integration and governance relevance
2025	Blockchain, artificial intelligence, e-government, public sector, decentralised, crime	Niche and impact-driven themes emphasizing institutional adoption, policy implementation, innovation outcomes, and risk governance, including crime-related and regulatory concerns	**Maturity phase**, marked by sector-specific applications, policy implementation, and risk governance with strong policy-relevant concerns

A closer examination of keyword transitions reveals several notable patterns. During the exploratory, dominant themes such as "digital identity," "smart city," and "digital storage" reflect an initial focus on technological possibilities and conceptual framing. The subsequent consolidation phase witnessed the emergence of "artificial intelligence" and "smart contract" as integrative themes, indicating a shift toward hybrid technological approaches and automated governance mechanisms. By maturity phase, the appearance of "crime" as a new dominant theme, absent in earlier periods signals growing scholarly attention to blockchain misuse, regulatory enforcement, and risk governance, coinciding with heightened global regulatory scrutiny following cryptocurrency market disruptions. Meanwhile, the gradual decline of "smart city" as a standalone theme suggests its absorption into broader "e-government" frameworks rather than diminishing research interest. These evolutionary patterns demonstrate that thematic shifts are driven not only by internal research dynamics but also by external factors including regulatory developments, technological convergence, and emerging governance challenges.

3.1.2 Strategic Thematic Map

A Strategic Thematic Map is used to examine the structural positioning and relative importance of key themes in blockchain-enabled e-governance research. By analyzing themes based on centrality and density, this approach identifies core, emerging, and niche topics, thereby providing insight into the strategic orientation and maturity.

Table 5. *Strategic thematic map: structural positioning of keyword clusters based on centrality and density.*

Thematic Quadrant	Representative Keywords	Structural Meaning	Governance Interpretation
Basic Themes	blockchain, distributed ledger, public sector, transparency, decentralization	High centrality, low density	Foundational concepts that form the core of blockchain-based e-governance research but remain broadly framed and weakly specialized. These themes anchor ongoing debates on decentralization, transparency, and public-sector digital transformation across all periods.
Motor Themes	cybersecurity, authentication, data privacy, artificial intelligence, government services, cryptocurrency	High centrality, high density	Mature and influential themes driving the field forward. They reflect governance priorities related to trust infrastructure, security, and intelligent public services, indicating readiness for implementation-oriented research and policy frameworks.
Niche Themes	emerging technology, financial system, crime, services infrastructure, trust	Low centrality, high density	Highly specialized topics with strong internal development but limited integration into the broader governance discourse. These themes represent targeted regulatory and risk-governance concerns that could gain wider relevance as institutional demands evolve.
Emerging or Declining Themes	smart city, digital transformation, e-government, economics, bitcoin	Low centrality, low density	Mixed trajectories: some themes reflect conceptual consolidation into broader governance frameworks (e.g., smart city, digital transformation), while others indicate declining relevance (bitcoin) or emerging interest (economics) in cost–benefit and sustainability analysis.

Figure 4 displays the thematic map of blockchain research in e-governance, organized around two dimensions, centrality on the horizontal axis representing relevance and density on the vertical axis indicating internal thematic development. This structure enables the identification of both theme importance and the maturity of research clusters.

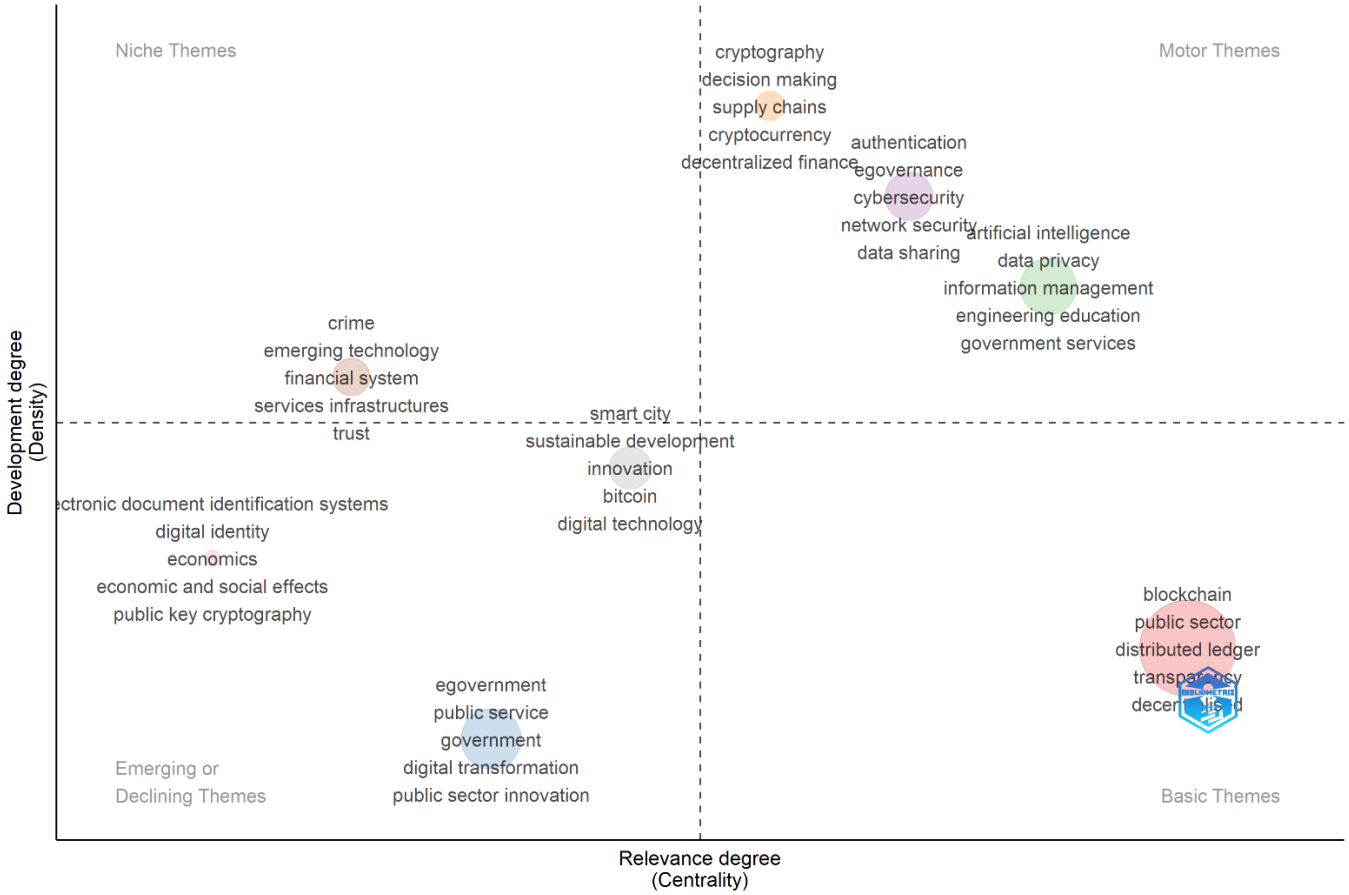

Figure 4. *Strategic thematic map based on centrality and density dimensions.*

To illustrate the practical relevance of each thematic quadrant, concrete examples from the reviewed literature provide grounding. Basic themes such as transparency and decentralization underpin applications across all six sectors but remain conceptually broad without standardized measurement indicators. For example, transparency is cited as a key benefit in taxation compliance (Setyowati et al., 2023), and land registration (Ooi et al., 2022), yet its operationalization varies significantly across these contexts, ranging from audit trail visibility to real-time transaction monitoring.

Motor themes reflect implementation-ready research with strong governance applicability. Specifically, cybersecurity and authentication protocols dominate e-voting studies, where (Khan et al., 2020), demonstrated vulnerabilities in transaction malleability attacks, and transportation research, where (Stockburger et al., 2021) implemented self-sovereign identity for decentralized identity management. The convergence of AI and blockchain emerges as a motor theme in intellectual property management, where (Song et al., 2021) proposed a proof-of-contribution consensus mechanism for IP protection, and in government information sharing, where smart contracts automate cross-departmental data verification (Zhang et al., 2023).

Niche themes such as crime prevention and financial system regulation appear in targeted applications with high internal coherence but limited cross-sector integration. Anti-corruption budget tracking using blockchain in India (Jadhav et al., 2025) and trust-building mechanisms in land tenure reform (Ameyaw & de Vries, 2023) exemplify how these specialized governance concerns address acute institutional needs. These niche themes could gain broader policy relevance as regulatory frameworks mature and demands for accountability intensify across jurisdictions.

Among emerging or declining themes, smart city and digital transformation show trajectories of conceptual absorption rather than disappearance: they are increasingly subsumed into integrated e-governance frameworks

(such as EBSI in Europe) rather than persisting as standalone research streams. Bitcoin exhibits clear thematic decline as scholarly focus shifts from public cryptocurrency debates toward permissioned blockchain architectures designed specifically for governance applications. Conversely, economics as an emerging theme signals growing attention to cost-benefit analysis and financial sustainability of blockchain deployment in public services, particularly regarding implementation costs in transportation (Baygin et al., 2022) and transaction expenses in taxation systems (Kim, 2022), areas that remain significantly underexplored in the current literature.

3.1.3 Evolution of global research participation

Following the thematic comparison, Table 6 highlights the leading countries contributing to this research domain, illustrating patterns of international collaboration and regional engagement. The dataset comprises 196 articles contributed by 688 researchers, encompassing both single-country publications (SCP) and multi-country publications (MCP) along with the corresponding MCP ratio relative to total output.

Table 6. *Top 10 Countries by corresponding author's contribution.*

No	Country	Articles	SCP	MCP	MCP %
1	China	15	12	3	20.0
2	India	13	12	1	7.7
3	Spain	9	7	2	22.2
4	USA	9	7	2	22.2
5	United Kingdom	7	5	2	28.6
6	Brazil	5	5	0	0.0
7	Indonesia	5	4	1	20.0
8	Belgium	4	3	1	25.0
9	Germany	4	2	2	50.0
10	Italy	4	4	0	0.0

Table 6 shows that China (15 articles, 20% MCP) and India (13 articles, 7.7% MCP) are the two leading contributors to blockchain research in e-governance based on corresponding author distribution. The United States and Spain each produced nine publications, indicating consistent engagement from both developed and emerging economies. Notably, European countries such as Germany (50% MCP) and the United Kingdom (28.6% MCP) exhibit a considerably higher degree of international collaboration compared to their Asian counterparts. This indicates a stronger orientation toward cross-border partnerships, as European research often emphasizes collaborative and interdisciplinary projects that enhance diversity and innovation. Such patterns reflect a broader trend in digital governance, where multinational cooperation plays a crucial role in developing scalable, interoperable, and policy-relevant blockchain solutions.

A more detailed examination of the two dominant contributors, China and India shows contrasting institutional and policy contexts that influence their research trajectories. China's leading position can be linked to its state-led innovation strategy and strong governmental commitment to blockchain integration within public administration. According to the Blockchain White Paper (2020) issued by the China Academy of Information and Communications Technology, public-sector authorities participated in 236 blockchain pilot projects between 2012 and 2020, with China taking a leading role in these initiatives (Yang et al., 2022). Since 2019, China has also developed the first e-government service platform utilizing blockchain technology in collaboration with a software company called 21ViaNet China Inc (Xu, 2021). These coordinated, top-down policies not only accelerate domestic implementation but also foster moderate levels of international academic collaboration, as reflected in China's MCP ratio of 20%.

In contrast, India's blockchain research landscape is characterized by decentralized governance and fragmented policy frameworks, which constrain large-scale collaboration and international engagement. Many studies originate from region-specific initiatives rather than coordinated national programs, reflecting a localized and exploratory research approach. For example, blockchain has been proposed as a solution for improving land administration management in Ghana (Rakesh et al., 2023), and as a framework for enhancing government budget tracking and

expenditure monitoring in India (Jadhav et al., 2025). Although India has produced a considerable number of studies on blockchain, most remain at the proposal or conceptual stage, focusing on suggested applications rather than large-scale implementation. This research orientation limits opportunities for international collaboration and contributes to India's relatively low MCP ratio despite its high publication output.

The contrast between China and India thus reflects two distinct governance logics that shape research productivity and collaboration patterns. China's rapid scaling of blockchain research and implementation is facilitated by its centralized, top-down governance structure, which reduces coordination and consensus costs enabling swift policy alignment, resource mobilization, and nationwide standardization (Lumineau et al., 2020). This pattern aligns with observations that since its inception, blockchain in China has been conceived as a centralized, state-led endeavour aimed at reshaping industry development patterns (Hung, 2024). Conversely, India's fragmented institutional landscape, characterized by varying state-level regulations and decentralized decision-making, increases coordination costs and slows the transition from conceptual proposals to large-scale implementation. This comparison is presented descriptively to highlight structural differences in governance capacity, without implying normative judgments regarding the superiority of either regime type.

Beyond the centralized (China) and fragmented (India) governance models, the European context offers a third comparative reference: a supranational governance approach that balances national autonomy with regional coordination. As shown in Table 6, European countries demonstrate notably higher rates of international collaboration, with Germany exhibiting the highest MCP ratio (50%), followed by the United Kingdom (28.6%) and Belgium (25%). This pattern reflects the European Union's emphasis on harmonized regulatory frameworks and cross-border research integration. Initiatives such as EBSI (Tan et al., 2023), which enables trusted digital services across member states, and the markets in crypto-assets (MiCA) regulation (Regulation (EU) 2023/1114, 2023), which establishes unified legal standards for blockchain-based assets, exemplify this supranational coordination model. Unlike China's top-down centralization or India's bottom-up fragmentation, the European approach represents a multilateral governance model that facilitates interoperability, shared standards, and reciprocal knowledge exchange across national boundaries. This structural orientation may explain why European researchers demonstrate stronger tendencies toward genuinely collaborative, multidirectional research partnerships.

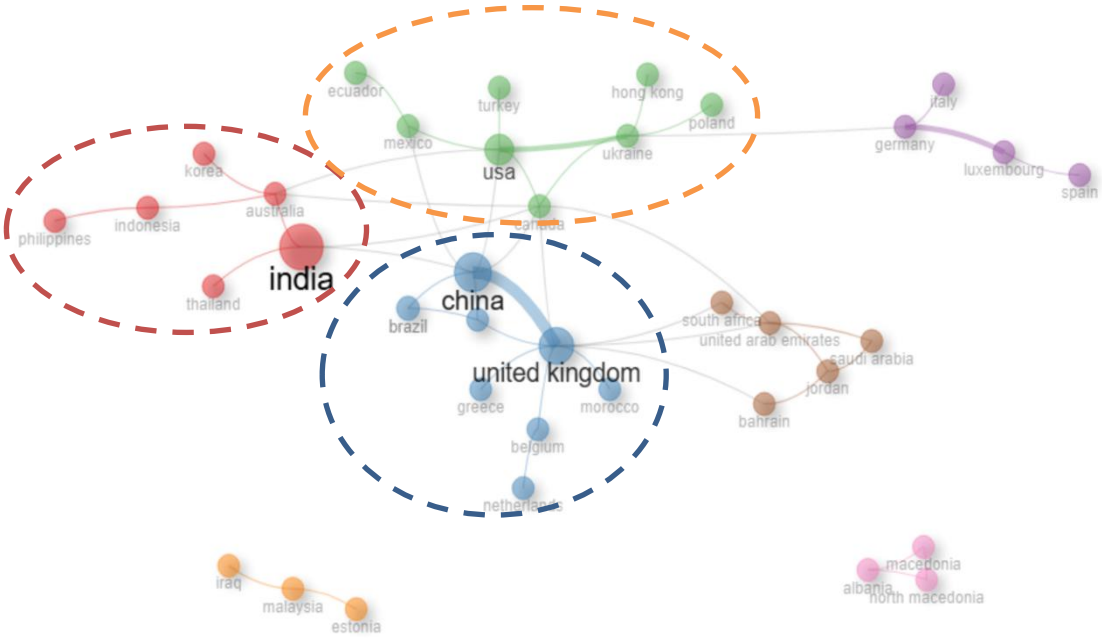

Figure 5. *Country collaboration network based on co-authorship analysis.*

Figure 5 illustrates the co-authorship network among countries publishing on blockchain applications in e-governance. Each node represents a country, with its size proportional to publication volume and edge thickness indicating the intensity of collaboration. The visualization reveals three major clusters that dominate the global research landscape: the blue cluster (China-United Kingdom), the red cluster (India), and the green cluster (United

States). The blue cluster, led by China and the United Kingdom, represents the most extensive collaborative network. China appears as a central actor with high publication volume and dense regional connections, primarily engaging with Asian partners such as Thailand and South Korea. This pattern reflects a centralized and predominantly inward-oriented collaboration structure, driven by strong government coordination through initiatives such as the blockchain service network (BSN), resulting in a one-directional knowledge-harvesting model rather than mutually reciprocal collaboration (Cao et al., 2020). In contrast, the United Kingdom acts as a bridge country, linking China and several European nations such as Greece, the Netherlands, and Belgium. This bridging position allows the UK to facilitate truly cross-border, multidirectional knowledge flows, strengthening interoperability across Asian and European research ecosystems.

India's cluster is more regionally concentrated; despite substantial publication output, its low MCP signals limited global collaboration and a research agenda still dominated by conceptual, domestically focused studies. This pattern indicates that India's blockchain initiatives, such as the Technology Stack and NBFLite, are primarily designed, implemented, and evaluated within national welfare and financial inclusion programs, generating strong domestic governance impacts but limited cross-border research engagement, thereby reinforcing its low international collaboration footprint (J. Singh et al., 2025).

The United States, as the center of the third major cluster, demonstrates an outward-oriented and globally distributed collaboration pattern that distinguishes it from both China's inward-focused model and India's regionally concentrated approach. The U.S. influence in the field manifests through three primary mechanisms. First, thematic leadership: American researchers have contributed significantly to governance frameworks and regulatory discourse, particularly addressing challenges arising from federal–state inconsistencies and the need for cross-jurisdictional coordination (Eyassu, 2019). Second, publication visibility: US-affiliated studies frequently appear in high-impact venues, amplifying their reach and citation influence across the global research community. Third, bridging connectivity: The United States maintains extensive co-authorship linkages with Europe, Asia, and the Americas, functioning as a cross-regional integrator that facilitates reciprocal knowledge exchange rather than unidirectional knowledge harvesting. This pattern is consistent with findings from recent bibliometric studies on global financial technology (FinTech) and blockchain collaboration networks, which identify the United States as a central node enabling multidirectional research flows (Duan, 2024). Unlike China's state-coordinated collaboration model, the U.S. approach reflects a decentralized but globally networked research ecosystem, where academic institutions, private sector actors, and government agencies contribute to a diverse and internationally engaged research agenda.

The findings directly support the claim that "international collaboration enhances influence" by showing that countries with genuinely reciprocal, cross-border knowledge integration (such as the UK and USA) achieve broader impact, whereas China's one-way, inward-focused knowledge-harvesting model limits the extent to which its collaborations translate into global influence. The comparative framing of centralized (China), fragmented (India), and supranational (Europe) governance models, alongside the cross-regional integrator role of the United States, provides a useful analytical foundation for future research examining how governance structures shape blockchain adoption trajectories and international research collaboration patterns in the public sector.

3.2 RQ2: Applications and key challenges

Understanding the applications and key challenges of blockchain in e-governance is essential for assessing how this technology can strengthen transparency, efficiency, and trust in the public sector, particularly when supported by effective data usage strategies (Begany & Gil-Garcia, 2024). Table 7 synthesizes the key applications and challenges of blockchain across six public sector domains, drawing on the reviewed literature to identify sector-specific implementation patterns, challenges, and advantages of adoption.

Table 7. *Blockchain applications and key challenges in the public sector domains.*

Application	Challenges	Advantages
1. Transportation sector (Stockburger et al., 2021; Baygin et al., 2022; P. Singh et al., 2022)	a) Data security & privacy issues: protecting user personal information. b) Lack of regulatory standards: no clear global regulatory standards exist.	a) Security & data protection: reduces data breaches and identity theft through a more secure b) Self-sovereign identity (SSI): allows users to have full control over their digital identity.

Application	Challenges	Advantages
	c) Energy efficiency & implementation costs: high energy consumption and significant investment. d) Social adoption & system reliability: public awareness, education, and stakeholder acceptance. e) Ethical & security concerns: ethically and preventing misuse.	c) Distributed data platform: facilitates secure, reliable, and efficient data sharing. d) Process automation with smart contracts: enables automated payments and approvals using blockchain-based smart contracts. e) Improved Reliability in Logistics Recording: Minimizes errors in shipment records.
2. E-voting (Salumaa-Lepik & Nisu, 2024; Khan et al., 2020; Jayakumari et al., 2024)	a) Transaction Flexibility: systems must adapt to diverse electoral needs. b) Regular Security Audits: cybersecurity reviews are essential. c) Public Awareness and Education: voters and officials need education and trust. d) Legal Compliance: must align with electoral laws. e) User Friendly: accessibility for all, including disabled voters. f) Validation efficiency: faster vote tallying required. g) Lack of Standards: no universal rules for e-voting. h) High Cryptographic Costs: expensive encryption operations.	a) Enhanced Security: prevents double voting. b) Tamper Resistance: votes cannot be altered. c) Improved Reliability: transparent and trustworthy processes. d) Cost and Time Efficiency: faster, cheaper elections. e) Smart contract authentication: secure voter verification without third parties.
3. Intellectual Property (IP) (W. Lu & Wu, 2024; Bonnet & Teuteberg, 2023; Song et al., 2021)	a) Collaborative Environments: complex multi-stakeholder systems. b) Digital Piracy: difficulty preventing unauthorized copies. c) Inefficient Registration: slow and non-transparent processes.	a) Real-Time Updates: instant IP data sharing. b) Tokenized Ecosystems: project support through tokenization. c) Digital Transformation: efficiency and innovation gains. d) Security and Cryptography: strong authentication and protection.
4. Land Registration System (Ameyaw & de Vries, 2023; Rashid et al., 2025; Ooi et al., 2022)	a) Cultural and Traditional Norms: land tenure shaped by customs. b) Oral contracts & gender segregation: inheritance and informal practices. c) Data Fragmentation: records scattered across institutions. d) Decentralized Systems: risks of disputes without central authority. e) Corruption and Bureaucratic: inefficiency and fraud in processes.	a) Processes Automation: streamlined administrative tasks. b) Secure Transactions: reliable and transparent records. c) Real Time Monitoring: AI/IoT-enabled data for policymaking.
5. Academic (Yfantis & Ntalianis, 2022; Jha, 2023; Tan et al., 2023)	a) Security and Privacy: protecting student and staff data. b) Lack of Regulatory: few established legal frameworks. c) High Costs: financial barriers for institutions. d) Adoption Barriers: low readiness among stakeholders. e) Interoperability: incompatibility across blockchain platforms.	a) Transparency and Security: fraud-proof academic records. b) Decentralized System: less reliance on central authorities. c) Administrative Efficiency: automated document workflows. d) Faster Verification: instant diploma validation. e) Global Interoperability: cross-border credential recognition.
6. Tax (Kochovski et al., 2022; Kim, 2022; Setyowati et al., 2023)	a) Standardization and Integration: limited technical standards. b) Data Quality: blockchain relies on accurate inputs. c) Transparency Limits: cannot detect unreported cash. d) Database Interoperability: disconnected private databases. e) Transaction Costs: high transaction volumes lead to higher expenses. f) Regulatory Uncertainty: unclear tax regulations.	a) Transparency and Security: immutable, tamper-proof data. b) Reliable Verification: cross-checking by multiple parties. c) Automation: streamlined tax compliance and monitoring. d) Cryptographic Security: strong data privacy protection. e) Improved Integration: secure links between databases. f) Accurate Analysis: better data for policymaking.

The sectoral synthesis in Table 7 reveals uneven sustainability readiness across three dimensions. Institutional continuity is best evidenced, with regulatory frameworks and pilot projects well-documented in transportation, e-voting, and land. Economic viability remains under explored, as financial analyses are largely absent from current literature. Socio-citizen acceptance is recognized but lacks empirical operationalization, particularly in e-voting and land registration contexts.

Building on these sectoral patterns, Figure 6 presents a phased research roadmap that sequences institutional, economic, and socio-citizen priorities across short-, medium-, and long-term horizons.

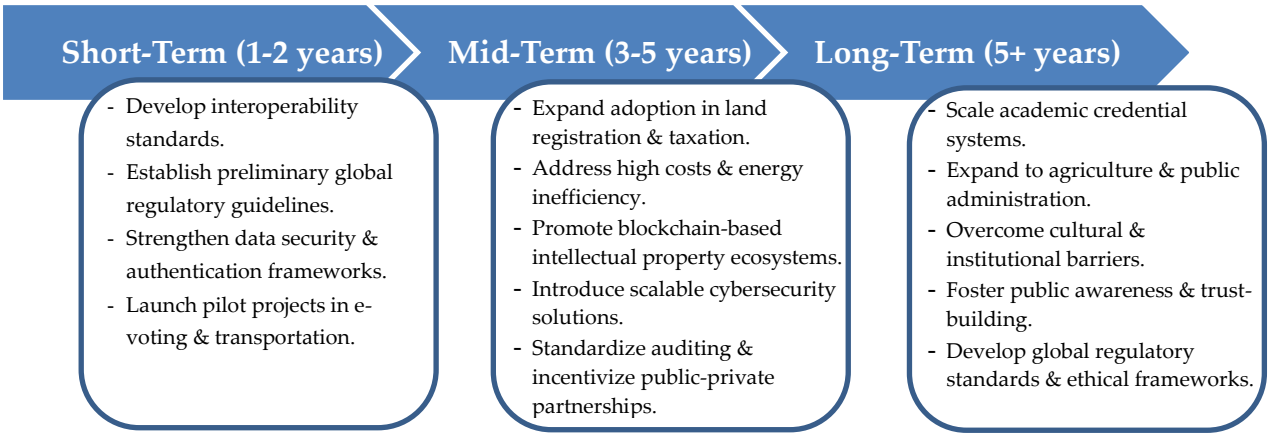

Figure 6. *Research roadmap for blockchain adoption in e-governance.*

Figure 6 presents the research roadmap for blockchain in e-governance. The roadmap organizes the cross-sector challenges identified in Table 7 into three temporal phases. Short-term priorities address regulatory alignment and interoperability; medium-term priorities target scalability, cost efficiency, and cybersecurity; and long-term priorities focus on socio-institutional adoption barriers including digital literacy, citizen trust, and cultural readiness. The specific gaps and opportunities associated with each phase are discussed in detail under RQ3.

3.3 RQ3: Gaps and future opportunities exist to advance blockchain adoption

The sector-specific opportunities and challenges reveal that barriers to blockchain adoption in e-governance are multidimensional, spanning technical, regulatory, and socio-institutional domains. The analysis highlights three critical gaps.

First, the technical dimension continues to face unresolved issues related to interoperability, scalability, and cybersecurity. China positioned at the center of the largest collaboration cluster and connected to technologically active partners such as the United Kingdom, Brazil, and Greece demonstrates the ability to deploy blockchain infrastructure rapidly due to strong state coordination (Cao et al., 2020). However, despite its scale, China's ecosystem still experiences limited cross-chain interoperability and restricted integration with external platforms, underscoring the need for internationally aligned standards and real-world pilots beyond simulation studies.

Second, the policy and regulatory dimension exhibits fragmentation and slow institutional alignment. India, which forms its own distinct collaboration cluster with countries such as South Korea, Australia, Indonesia, and Thailand, illustrates how regulatory uncertainty and administrative misalignment can delay implementation. Although India has strong domestic initiatives in land administration (Ooi et al., 2022), varying state-level procedures and evolving digital-governance frameworks slow nationwide scaling. Meanwhile, the United States another major cluster center that connects Europe, Asia, and the Americas faces challenges due to its decentralized regulatory environment. In the United States, federal–state inconsistencies and overlapping regulatory jurisdictions slow progress toward national standards, even as state and local governments advance blockchain experimentation more rapidly (Eyassu, 2019).

Third, the socio-institutional dimension reveals gaps relating to citizen trust, digital literacy, organizational readiness, and cultural acceptance. China's centralized governance model allows rapid pilot deployment, a pattern associated with strong top-down coordination structures where policy implementation efficiency may come at the cost of broader stakeholder participation and deliberative consensus-building (Bougherra et al., 2023). India faces

constraints associated with uneven digital literacy, bureaucratic inertia, and the need to build community trust for reforms affecting land rights and public services. In the United States, socio-institutional barriers emerge from varying organizational readiness, strong privacy expectations, and the need for broad stakeholder alignment across federal and state agencies.

Future opportunities arise from directly addressing these gaps. In the short term, establishing interoperable standards and clearer regulatory coordination will be essential for enabling cross-border and inter-agency applications such as identity management, taxation, and academic credentialing. Governance styles will shape early opportunities: China can rapidly impose unified national standards, while India and the United States require greater consensus-building to balance innovation with privacy, accountability, and institutional diversity. In the medium term, opportunities exist to scale pilots in high volume sectors, such as transportation, taxation, and academic records in ways that align with the collaboration patterns observed in the three major clusters. In the long term, sustainable adoption will depend on integrating technical advances with social-science insights, increasing citizen trust, strengthening digital literacy, and adapting governance institutions to blockchain-enabled processes.

By moving from descriptive accounts toward strategic solution pathways, this discussion positions blockchain not only as a technological innovation but also as a governance transformation tool. The identified gaps therefore form the basis for future research agendas and public-sector strategies that can advance sustainable, inclusive, and globally coordinated blockchain adoption.

3.4 Practical and policy implications

The findings clearly demonstrate that China has emerged as the global leader in blockchain research within the e-governance domain, contributing the highest number of publications addressing public sector applications such as transportation, e-voting, intellectual property protection, land registration, taxation, and academic records. China's dominance is further reinforced by extensive government-backed pilot projects that translate research into large-scale practice, positioning the country not only as a scientific leader but also as a pioneer in real-world implementation. Meanwhile, India ranks second globally, with a growing body of research and pilot programs particularly focused on land registries and property rights management. These initiatives leverage blockchain's immutability and transparency to reduce corruption, minimize fraud, and accelerate dispute resolution. India's focus reflects its strategy to apply blockchain in domains where governance challenges are most acute, thereby enhancing administrative trust and efficiency.

In China, blockchain has been deployed across multiple government functions, including electronic licensing in Nanjing (Zhang et al., 2023), e-invoicing in Shenzhen (Liao et al., 2025), and integrated public service platforms in Guangdong Province (Hou, 2017). These implementations demonstrate blockchain's potential to enhance administrative efficiency, reduce errors, strengthen transaction transparency, and build citizen trust. However, these initiatives also reveal persistent challenges, including limited interoperability across provinces and the absence of standardized regulatory frameworks. In contrast, India has concentrated its blockchain adoption in land registry systems, particularly in Andhra Pradesh and Telangana (Kumar, 2024), addressing deeply rooted issues of corruption, data manipulation, and legal disputes in property governance. The immutability and transparency of blockchain in this context significantly reduce fraud risks and reinforce public confidence in government records. Detailed case descriptions and their specific practical and policy implications are provided in Appendix A.

The cases of China and India demonstrate that blockchain in the public sector should be viewed as both a technological and institutional innovation. While China illustrates the scalability of blockchain across diverse government functions, India highlights its transformative potential in addressing governance vulnerabilities. The findings suggest that successful adoption depends on supportive policies, interregional coordination, interoperability standards, and citizen-centric design. For global policymakers, these insights underscore the importance of aligning technological deployment with institutional realities and regulatory safeguards to maximize blockchain's societal value.

4 CONCLUSION

The result demonstrates that blockchain has become a crucial part of digital transformation in e-governance. It holds strong potential to improve transparency, security, efficiency, and even automation across different areas of the

public sector. The findings reveal a rapidly expanding research landscape, with China, India, and the United States emerging as the three most influential collaboration clusters. Each cluster demonstrates distinctive approaches to blockchain-enabled e-governance, shaped by differences in governance models, regulatory environments, and institutional capacities.

Across the reviewed studies, blockchain applications in government predominantly focus on transportation, e-voting, IP, land registration, academic and tax. The research roadmap suggests that adopting blockchain in e-governance should follow a phased approach. It starts with building strong technical foundations, then moves on to improving efficiency and cost management, and finally to addressing institutional and cultural barriers. In this light, blockchain should be regarded not only as a technological innovation but also as an institutional one. Despite promising advancements, technical challenges such as scalability, interoperability, and cybersecurity are compounded by regulatory fragmentation and socio-institutional resistance. First, technological limitations remain, particularly in interoperability, scalability, and cybersecurity. Second, policy and regulatory environments evolve unevenly across countries, with fragmented frameworks and misaligned institutional jurisdictions slowing integration. Third, socio-institutional barriers related to citizen trust, organizational readiness, and digital literacy continue to affect the pace of adoption, especially in decentralized governance systems.

Country cases further illustrate the multi-dimensional nature of blockchain adoption. China demonstrates rapid, large-scale deployment supported by strong state coordination. India emphasizes targeted reforms in land governance to address structural issues such as corruption and record manipulation. The United States, despite strong innovation capacity, faces adoption constraints from overlapping federal-state jurisdictions and fragmented regulations. These contrasts highlight that blockchain's success as a governance innovation depends not only on technological capability but also on institutional coherence, regulatory clarity, and citizen-centered design.

Future research should therefore integrate technological, policy, and socio-institutional perspectives to better understand how blockchain can be sustainably embedded into public-sector systems. Scholars and policymakers must prioritize standardization, regulatory coordination, capacity building for digital transformation, and rigorous real-world pilots. Advancing blockchain in e-governance requires moving beyond conceptual proposals toward evidence-based frameworks that balance innovation with accountability, privacy, and inclusiveness. By addressing these gaps, governments can fully leverage blockchain's transformative potential to enhance transparency, efficiency, and public trust.

ADDITIONAL INFORMATION AND DECLARATIONS

Conflict of Interests: The authors declare no conflict of interest.

Author Contributions: L.N.: Conceptualization, Methodology, Resource, Writing – Original draft preparation. F.A.: Supervision, Visualization, Writing – original draft. M.D.W.S.: Visualization, Writing – original draft, Formal analysis. W.R.: Data curation, Visualization, Investigation. A.S.: Writing – Reviewing and Editing. A.S.: Validation, Writing – original draft, Formal analysis. T.S.: Writing – Reviewing and Editing. R.N.: Writing – Reviewing and Editing.

Statement on the Use of Artificial Intelligence Tools: The authors declare that they didn't use artificial intelligence tools for text or other media generation in this article.

Data Availability: The data supporting the findings are openly available in the Zenodo repository at https://doi.org/10.5281/zenodo.17934229.

APPENDIX A

Table A1. *Practical and policy implications.*

Country	Case / Area	Implementation Description	Practical Implications	Policy Implications
China	**Electronic Licensing Platform / Nanjing** (Zhang et al., 2023)	Blockchain applied for government information sharing via an electronic licensing platform and improved efficiency and reduced errors.	- Improved efficiency. - Reduced administrative errors.	Policies needed to address geographic barriers and ensure cross regional interoperability.

Country	Case / Area	Implementation Description	Practical Implications	Policy Implications
China	**Blockchain E-Invoice / Shenzhen** (Liao et al., 2025)	Blockchain based electronic invoice system supporting encryption, transaction synchronization, and integration of funds & invoices.	- Enhanced transparency and traceability of transactions. - Reduced fraud risks.	Regulatory support required for cross-sector expansion (finance, healthcare, transportation).
China	**E-Government Service Platform / Chancheng District, Guangdong Province** (Hou, 2017)	One Stop Service public platform with blockchain for identity, credit, and information transparency.	- Strengthened public trust. - Efficient access to public services.	- Need national standard on digital identity. - Policies should encourage government industry collaboration.
India	**Land Registry Systems / Andhra Pradesh & Telangana** (Kumar, 2024)	Blockchain introduced in land registries to address corruption, data manipulation, and legal disputes.	- Reduced risks of property fraud and faster legal processes. - Increased public trust.	- Agrarian policies need to support nationwide digitalization. - Land governance regulations must integrate with blockchain.

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Acta Informatica Pragensia is published by the Prague University of Economics and Business, Czech Republic | eISSN: 1805-4951