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Review

Blockchain barriers in public organizations: A systematic literature review

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ABSTRACT

Blockchain technology has garnered attention for its potential to revolutionize public sector services by enhancing transparency, efficiency, and trust. However, adoption remains hindered by critical organizational and technical barriers, which are underexplored in current literature, particularly from an economic-organizational perspective. This paper systematically reviews recent studies to identify sector-specific challenges, including interoperability issues and a shortage of technical expertise. By addressing these barriers, the findings propose tailored strategies to facilitate effective implementation, offering practical insights for public sector stakeholders and laying a robust foundation for future research.

1. Introduction

Blockchain technology is recognized as a General Purpose Technology (GPT) [1], with applications extending beyond cryptocurrencies. Interest in its non-cryptocurrency use has significantly grown in recent years.

Blockchain, the leading distributed ledger technology, consists of linked data blocks forming a continuous chain, managed through a decentralized peer-to-peer network. As noted by Yaga et al. [2], transactions in blockchain systems are cryptographically secured, transparent, and immutable, and are usually processed without a central authority. Blockchain can significantly enhance public sector services by improving security, accountability, transparency, and efficiency. Such benefits, however, are often counter-balanced by organisational and institutional barriers that remain under-researched. Public records management and healthcare are key promising application areas [3]. It can streamline registration processes, increase reliability, eliminate paper documents [4], and give citizens greater control and traceability over their healthcare data.

Recent literature highlights potential blockchain benefits and challenges in the public sector, emphasizing rapid technological evolution [5]. However, empirical studies based on concrete cases are scarce [6], and analyses on integration barriers are limited [7].

Policy discussions on blockchain emphasize economic potential and seek best practices, addressing governance, legal implications, interoperability, security, and privacy. Nonetheless, practical deployment remains limited compared to other technologies.

Existing reviews often neglect an economic-organizational perspective and rarely differentiate public from private sector applications, highlighting the originality and relevance of this study.

This paper systematically reviews blockchain applications in the public sector, conceptualizing innovation as "a process by which new ideas, objects, and practices are generated, evolved, or transformed, and which are novel to the adopting entity" [8], without prescriptive biases. Furthermore, results from literature review is compared with data available on 270 blockchain applications in the public sector.

The '*Preferred Reporting Items for Systematic Reviews and Meta-Analyses*' (PRISMA) approach [9] was applied to identify relevant studies, followed by a text mining analysis to extract key themes. The findings highlight significant opportunities and context-specific challenges, particularly in healthcare, education, data management, public finance, and e-voting. The most recurrent challenges include issues of interoperability and a lack of technical expertise, emphasizing the necessity for tailored integration strategies.

Practical implications emphasize the importance of investment in training, infrastructure, and clear regulatory frameworks for privacy, data protection, and stakeholder accountability. Public trust through transparency and education is also crucial.

The originality of this study lies in addressing economic-organizational barriers specific to the public sector, filling a gap identified in previous literature. This paper consolidates fragmented research and provides an evidence-based overview, contributing a foundation for future research.

The structure of the paper is as follows: the Introduction outlines

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blockchain's potential, identifies the research gap and objectives. The Related Work section reviews blockchain adoption literature and introduces research questions. In Section 3 the methodology is described, whereas Section 4 presents and discusses the main results. In Section 5 results from literature review are compared with data from European case studies. Finally, the Conclusions summarize contributions and suggest future research directions.

2. Related work and research questions

Despite the large number of publications on blockchain, most reviews still gravitate toward fintech and digital-currency themes [10,11], leaving non-crypto applications under-explored. The interdisciplinary nature of blockchain, spanning computer science, economics, management, and organizational studies, has led to a fragmented literature: technical analyses often ignore economic and organizational incentives, while managerial studies overlook key technical constraints such as interoperability and scalability. Yet effective public-sector adoption requires integrating these perspectives to address both socio-technical governance and organizational design. While economics takes a distinctive approach to problem-solving and decision-making, based on agents' behaviours and their interactions, computer science primarily focuses on system design, algorithm optimization, and information management. An interdisciplinary approach is needed to address critical technical issues, such as interoperability and scalability, without losing sight of the economic-organizational dynamics, such as resistance to change and cultural barriers. As a continuously expanding technology, updating the state of the art is important, possibly on an annual basis [5].

In the existing literature, not all reviews adopt an economic-organizational perspective. To fully investigate how blockchain may affect public or private organizations and their organizational structures, it is important to highlight major challenges the adoption of blockchain implies. Some authors have noted the lack of studies investigating and examining the barriers to blockchain integration in the public sector, proposing to fill this gap [7]. In the literature on innovation, these are frequently referred to as innovation barriers [12,13]. Recognizing and comprehending these barriers is considered a key factor for the successful management of the adoption process [14,15].

A specific limit to existing reviews lies in the lack of attention on the public sector. Although several studies have conceptually or empirically analysed the barriers to blockchain integration at the organizational level [16–19], seeking to understand why, despite its benefits, organizations struggle to implement this technology [20], they have not focused specifically on the public sector. While there are other reviews in the literature focused on this area [3,5], many focus on specific domains-such as e-government, smart contracts or digital infrastructure. The specificity of the public sector lies in the different nature of the goals pursued. In the private sector, organizational strategies frequently emphasize economic efficiency and control over resources, whereas in the public sector objectives involve not only economic dimensions but also social, political, and institutional goals. In this context, decisions may generate both direct resource impacts and broader social or institutional consequences (Meccheri, 2003).

A few notable contributions illustrate both progress and gaps. Moura, Brauner, & Janissek-Muniz [21] highlight blockchain's potential for enhancing information security, data openness, and citizen participation, emphasizing transparency and the use of smart contracts in public procurement. Rodríguez Bolívar & Scholl [22] map the nascent body of knowledge in blockchain applications for Digital Government. They indicate the current literature's bias toward fintech and identify a significant research gap regarding public-sector-specific studies. Their analysis advocates further research on legal frameworks, governance models, trust, transparency, democratic impacts, and public-sector reform enabled by blockchain. Even the most recent academic reviews, which testify to a growing interest in the economic sphere towards the topic [23,24], do not specifically address the barriers to the blockchain integration in the public sector.

To address gaps in the existing literature, this review pursues an explicitly interdisciplinary and economic-organizational perspective. It investigates two research questions.

- **RQ1**: How is blockchain technology integrated into the public sector?
- **RQ2**: What organizational and technical challenges does the public sector face when integrating blockchain technology?

The RQ2 can be considered as sub-level question within RQ1. Accordingly, a two-step analysis is conducted: (i) database search and study selection, and (ii) data extraction and thematic analysis of both questions. For RQ1, themes are derived from the diverse areas of public administration potentially affected, such as healthcare, education, e-voting, and public finance. The thematic aspect of RQ2 lies in the bijective relationship between benefits and obstacles on the one side, and sector of analysis on the other side. This issue is addressed through a text mining technique. More detailed discussion is in the following methodological section.

Methodologically, the review analyses academic literature as the primary unit of evidence, contextualizing institutional settings and project examples reported in the selected studies. Barriers are synthesized as conceptual insights rather than as project-specific observations, enabling a systematic understanding of the factors that shape blockchain adoption in the public sector. It is also important to note that the relationship between challenges or benefits and the sectors involved is not strictly sector-specific or one-to-one. Some opportunities and obstacles may span across both public and private domains. Furthermore, the barriers are synthesized here as conceptual categories emerging from scholarly research, rather than as empirical observations from individual projects.

3. Methodology

To investigate the integration challenges of blockchain technology within the public sector, a Systematic Literature Review (SLR) as a standalone and independent study is conducted. This work helps to establish a comprehensive understanding of a research domain by collecting and synthesizing findings from multiple empirical studies [25,26]. This approach uncovers the state of knowledge in fields characterized by diverse lines of inquiry and interdisciplinarity, identifying critical areas where further research is needed [27,28]. To minimize bias and reach reliable conclusions, a transparent, reproducible, and step-by-step methodology is adopted [26]. The method unfolds in two stages: (i) database search and study selection; (ii) data extraction and analysis.

3.1. Database search and studies selection

To identify eligible articles, we searched Scopus and Google Scholar to capture the field's interdisciplinarity (computer science, economics, management, organizational studies). The search was made with filters concerning document types and publication years. The initial literature search was conducted in February 2024 and was subsequently updated through a top-up search in July 2024, specifically to capture early-access and recently indexed publications. The review covers literature published from January 2020 through early 2024, up to the point when the SLR process was initiated. While this two-step approach mitigates potential bias due to time-lagged indexing, it is still possible that some papers published in late 2024 were not yet available in the databases at the time of the search. Given this pace of change, a five-year review window seems appropriate and ensures coverage of the post 'hype-cycle' policy landscape.

Following prior studies, keywords were selected to identify relevant

academic publications [29]. Queries combined terms for the public sector/administration, blockchain, and integration barriers/challenges (e.g., "public sector", "government", "public administration", "blockchain", "challenges", "barriers", "organizational", "technical"). For the purposes of this research, the definition of the public sector adopted is from the OECD (2008). Specifically, the concept of "*public sector*" comprises all government-owned and government-operated entities and services, with the primary functions of providing public goods and services, markets regulations, and implementing public policies [30]. Examples include government ministries, public schools, public hospitals, police departments, and public transportation services [31].

Conversely, the idea of "*public administration*" involves the implementation of government policy and the management of public programs [32]. Functions of public administration include policy formulation, budgeting, human resource management, and the administration of public programs [33]. Examples include drafting regulations, managing public funds, overseeing government projects, and delivering public services [34]. Therefore, the distinction between the concepts of "*public sector*" and "*public administration*" entails that the public sector refers to the "*what*," while public administration refers to the "*how*", involving the execution government policies [31,35]. The query refinement process used to select articles is detailed in Table A1 of the Appendix.

The 'Preferred Reporting Items for Systematic Reviews and Meta-Analyses' (PRISMA) approach [9] was employed to identify eligible studies. The articles eligibility followed four phases: definition of inclusion and exclusion criteria, title and abstract analysis, full-text assessment, and cross-referencing check.

Inclusion and exclusion criteria were applied to ensure high-quality and relevant articles. Articles published in the last five years, written in English, peer-reviewed, and focusing on blockchain integration challenges in the public sector were included. While grey literature - such as reports, dissertations, and working papers - can offer valuable contextual insights, this review focused exclusively on peer-reviewed academic publications and grey sources were not included in the core analysis. Nonetheless, select insights from non-peer-reviewed documents will be referenced in the Discussion section, where appropriate. Inclusion and exclusion criteria are detailed in Table 1.

Using the databases Scopus and Google Scholar, a check for potential duplicates was performed, and none were identified. At the end of this phase, 258 articles were identified. The description of the methodological process used in the review is summarized in the flowchart in Fig. 1.

In the subset of articles matching the inclusion and exclusion criteria, a title and abstract analysis is performed. The authors independently read titles and abstracts to determine whether each publication met the inclusion criteria [29,51]. The titles and abstracts evaluation has led to the exclusion of 174 articles that did not satisfy the criteria. The full texts of the remaining 84 articles were then scrutinized through a full-text assessment, resulting in the exclusion of an additional 47 articles. Ultimately, 37 articles were deemed suitable for the review. Finally, a cross-referencing check was conducted. The references of the selected articles are examined, but no additional studies meeting the criteria were found. The year distribution of the selected publications is shown in Fig. A3, whereas the distribution of publications by country is in Fig. A4.

Table 1
Inclusion and exclusion criteria.

Criteria	Inclusion	Exclusion
Publication Date	Articles published within the last 5 years	Articles published before the last 5 years
Research Focus	Focus on blockchain integration challenges in the public sector	Not addressing the integration challenges or not focused on the public sector
Language	English	Non-English languages
Document Type	Peer-reviewed academic articles	Editorials, opinion pieces, review papers, grey literature
Relevance	Directly addresses research questions	Does not contribute to research questions

Table 2
Use cases of blockchain in the public sector (RQ1).

Application Domain	Use Case Description	References
Healthcare	Management of medical records, interoperability, and privacy.	R. Zhang et al. [36]; Dhingra et al. [37]; Lu et al. [38]; Mustafa et al. [39] Verma and Sheel [40]; Bustamante et al. [41]
Education	Verification of academic credentials and digital identity.	Tan et al. [42]; Dash et al. [43]; Haneem et al. [44]
Data Management	Reliability, transparency, and security for sensitive data.	Lu et al. [38]; Mustafa et al. [39]; R. Zhang et al. [36]; Clavin et al. [45]; Du et al. [46]; Anyanwu et al. [47]
Public Finance	Crowdfunding, fund management, and financial auditing.	Radynskyy et al. [48]; Hung [49]; Prux et al. [50]
E-voting	Security and transparency in electoral processes.	Clarke et al. (2023); Verma and Sheel [40]

Article-level country attribution was adopted as a comparable unit of analysis. The observed geographical distribution also opens the possibility that contextual factors - such as institutional capacity or trust in government - may influence adoption dynamics. This interpretation is further explored in the Discussion section, where supporting evidence from the literature is presented.

3.2. Data extraction and analysis

We applied thematic analysis (Clarke et al., 2023), combining manual coding with a Python-based text-mining module to enhance transparency and replicability. The process comprised.

1. Familiarization.
2. Label Creation.
3. Defining and Naming Themes.

We also conducted a structured qualitative appraisal of the 37 studies included in the review. Each study was categorized by methodological type (e.g., literature review, survey, case study, etc.), and an evaluation of its main strengths and limitations was provided. This qualitative assessment, aimed to complement the data-driven analysis, is synthesized in Appendix (see Table A4), providing an overview of the study types, their distribution, and the main qualitative observations.

In phase 1 of data extraction and analysis, each of 37 selected article was read to fully understand its content and context. The familiarization phase is the base for the Label Creation phase, which is needed to define the themes. Accordingly, the main keywords to be investigated through text mining are identified. In response to RQ1, it emerges that multiple areas involved in public sector activities may potentially be affected by blockchain adoption. In response to RQ2, labels were identified to highlight the main challenges and obstacles to blockchain adoption in the public sector.

In the third phase of the process, a Python-based text mining technique was integrated to extract from the full texts and their frequencies. For RQ1, the co-occurrence of key terms informed the classification of articles into thematic clusters, summarized in Table A2. For RQ2, Table A3 outlines the main organizational challenges in blockchain adoption based on their frequency and recurrence.

To the best of our knowledge, no prior studies have employed this methodology for examining organizational and technical barriers to blockchain adoption in the public sector. This allowed to identify

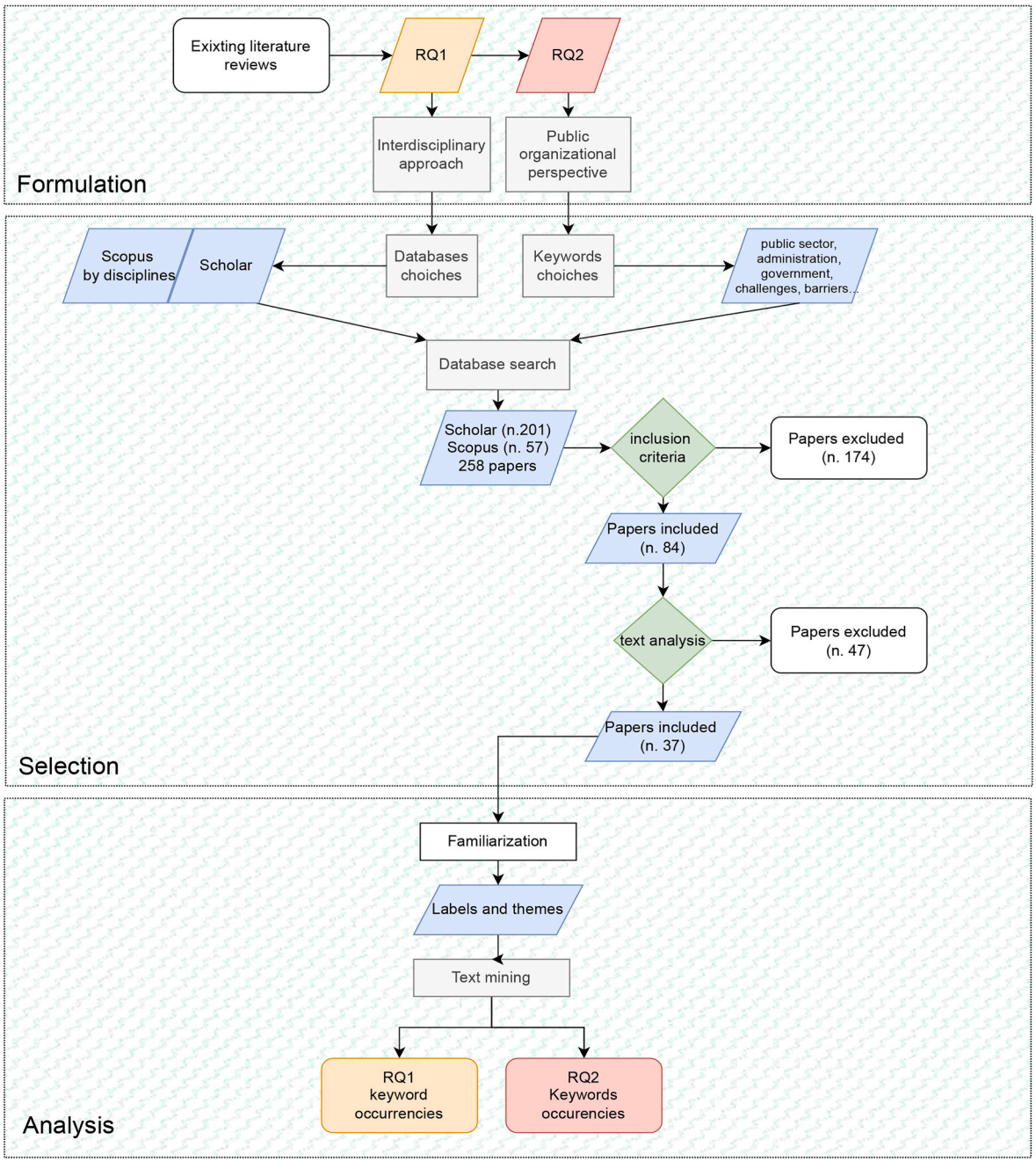

Fig. 1. Flowchart of SLR.

emergent themes and quantify their frequency, offering a robust foundation for addressing RQ2. Moreover, the insights derived from the coding process provided additional validation for the findings related to RQ1, which had been addressed using Boolean operators.

4. Results of the SLR

In this section, the main findings from the review are synthesized and discussed, addressing the two research questions.

RQ1: How is blockchain technology integrated into the public sector?
RQ2: What organizational and technical challenges does the public sector face when integrating blockchain technology?

Our review indicates a recent and increasing focus on the potential applications and research evolution of blockchain within the public sector, but a relatively small number of articles and journals with multiple contributions on this topic was found. The publication pattern and limited body of literature suggest that this area is still in its developmental stage [25].

4.1. Blockchain integration in the public sector (RQ1)

Addressing RQ1, the adoption of blockchain in the public sector reveals both substantial opportunities and significant challenges. The most frequent application areas identified include healthcare, education, data management, public finance, and e-voting. The distribution of article citations relevant to the domain analysed in relation to the first research question is presented in Table A5 of the Appendix.

4.1.1. Healthcare

Blockchain offers attributes that could revolutionize healthcare systems, particularly in patient data management, improving interoperability and protecting privacy. It is recognized as a reliable solution for storing and managing electronic health records (EHRs). Blockchain could be used to establish a chronological record of patient data, allowing both patients and doctors to efficiently review and analyse medical information [36].

In terms of interoperability, blockchain addresses current challenges related to ineffective communication between healthcare institutions. Storing health records on a blockchain could create a unified system accessible to authorized stakeholders. A study examining a distributed electronic health records ecosystem using blockchain technology found improvements in processing capacity, information sharing, and organizational flexibility [37].

Privacy is a critical concern when handling sensitive health data, particularly in the context of digital infrastructures. While blockchain is often promoted as a secure and transparent technology, its core strength lies in ensuring data integrity and traceability, rather than confidentiality. Some studies argue that blockchain may offer improved privacy protections compared to traditional health data storage systems [38], particularly when combined with encryption, identity management, and access control mechanisms [39]. However, these enhancements rely on off-chain architectures and complementary systems, and do not stem from the native properties of blockchain itself.

One often-cited example of blockchain application in healthcare is Estonia's e-Health Record system, which does not store medical records on-chain but uses blockchain to secure access logs and ensure auditability of data transactions [40]. This approach emphasizes transparency in access, rather than storing patient information directly on the blockchain. Additionally, IBM's MiPasa project, developed in response to the coronavirus pandemic, demonstrates blockchain's potential for recording and sharing health information, particularly related to antibody testing [41].

In summary, while blockchain may offer potential benefits in healthcare, its use for storing or managing highly sensitive personal data remains controversial. The reviewed literature underlines the importance of carefully designing hybrid architectures that combine blockchain with privacy-preserving technologies.

4.1.2. Education

Education has become a key public sector domain where blockchain solutions are being actively developed and tested. Blockchain offers a secure, tamper-proof system for issuing and verifying academic credentials. The University of Nicosia in Cyprus has implemented a system where academic certificates are authenticated through the Bitcoin blockchain, helping to reduce fraud and streamline the verification process for both students and employers [42]. Blockchain technology shows potential also in the area of digital identity management, simplifying access to educational resources and services [42]. Ngee Ann Polytechnic in Singapore is the first public educational institution in the country to use blockchain to verify the validity of its diplomas [44].

Furthermore, blockchain can enhance student innovation and creativity, enhancing manuscript submission, and ensuring timely and accurate peer reviews [43]. Finally, blockchain has supported the creation of distinct online learning platforms, facilitated the development of academic projects, and, most importantly, reduced fraud while enhancing security and privacy in the education sector [43].

4.1.3. Data Management

Blockchain has emerged as a promising solution for industries that demand high levels of data security, privacy, and trust [38]. Its suitability for managing and storing sensitive data, such as electronic medical records [36] and critical governmental information [45], highlights its potential to enhance the reliability and authenticity of data [46]. Blockchain offers significant improvements in public sector data management, providing greater trust, transparency, and security [39]. In public-private partnerships, blockchain can play a key role in reducing information asymmetry, by protecting integrity of data and creating a tamper-proof record that traces data back to its origin. This capability is especially important in long supply chains or in managing sensitive information [46]. In the governmental sphere, where transparency, security, and efficiency are paramount, blockchain stands out as a disruptive force capable of ushering in a new era of digital governance [47].

4.1.4. Public finance

In the realm of public crowdfunding and fundraising, blockchain technology has emerged as a powerful tool for enhancing transparency, security, and efficiency. By leveraging blockchain, a decentralized fund can be established where anyone can contribute, ensuring that the management and allocation of these funds are transparent and trustworthy. Digital assets or tokens can be issued to represent equity in local development initiatives, facilitating the transfer of ownership stakes in projects. Smart contracts further streamline this process by creating a decentralized budgeting system, where fund allocation decisions are made through participant voting or upon reaching specific development milestones [48].

Blockchain also shows significant potential in revolutionizing agricultural financing by improving farmers' access to funds. A key application is the tokenization of physical assets like crops, livestock, and machinery, converting them into unique digital tokens. This transformation enhances their tradability, enabling their use as collateral in decentralized finance (DeFi) markets [49].

In the context of government accounting, blockchain technology is highlighted in several key areas, including auditing, budgetary and financial management, public procurement, contracts, accounting records, financial transactions, and asset transfers. The documented use cases suggest that blockchain can offer significant benefits, but challenges remain, particularly in terms of regulatory frameworks, scalability, performance, and the cultural shift required for adoption, especially given the scarcity of established use cases. Notable examples include Estonia's health platform and the Dubai Blockchain Strategy, both of which facilitate financial transactions via blockchain, a new model for recording land ownership in India, and a system for tracking imported goods into China [50].

4.1.5. E-voting

Although e-voting schemes have the potential to address challenges associated with traditional paper ballot elections, most existing systems rely on a centralized third party to manage the election process. This reliance creates vulnerabilities, susceptible to both internal and external threats. To address the limitations of centralized e-voting systems, many researchers have proposed leveraging blockchain technology to host e-voting schemes. Blockchain operates on an append-only model, where the immutable nature of its ledger discourages vote tampering and manipulation, once votes are recorded, they cannot be altered or erased (Clarke et al., 2023). Several countries have explored or implemented blockchain-based voting systems: Estonia has integrated blockchain into its voting process, and South Korea has successfully used blockchain-based e-voting in local elections [40].

However, achieving both ballot secrecy and election verifiability within blockchain-based voting remains a complex challenge. Blockchain's transparency can conflict with the need to keep votes confidential, and additional cryptographic techniques are often needed.

As a result, most current implementations focus on managing polls and surveys or on enhancing citizen participation in local and national decision-making processes, as discussed in Section 5, where some case studies are analysed. This evidence further highlights the limitations of blockchain for formal electoral purposes.

Table 2 summarises the application domains and descriptions of the most frequent blockchain use cases in the public sector.

4.2. Organizational and technical challenges in blockchain integration (RQ2)

To analyse the challenges encountered during blockchain adoption in the public sector, a specific framework is adopted [52], which classifies barriers into four categories.

- o Organizational Barriers.
- o Interaction-Specific Barriers.
- o Barriers Related to Perceived Characteristics of the Innovation.
- o Contextual Barriers.

The citations of articles addressing barriers to technology implementation, as investigated in the second research question, are summarized in Table A6 of the Appendix.

4.2.1. Organizational Barriers

Organizational barriers refer to internal obstacles within organizations, such as resistance to change, lack of technical expertise, and resource shortages. In the healthcare sector, the lack of understanding and expertise in blockchain technology among healthcare professionals leads to reluctance, implementation difficulties, and potential errors in using blockchain-based systems [53].

In the education sector, staff often lack the necessary technical skills, causing resistance to adoption and delays in implementation [43]. The high costs associated with blockchain implementation pose an additional obstacle, especially for institutions with limited budgets.

In public finance, a general lack of awareness about blockchain technology and its cost-effectiveness within public agencies hampers adoption [50]. Additionally, difficulties in replacing or adapting existing traditional systems present a significant challenge.

4.2.2. Interaction-Specific Barriers

Interaction-specific barriers refer to interoperability and integration issues between systems. In the healthcare sector, the absence of standardized protocols for integrating blockchain with existing systems hampers effective communication and data sharing between different institutions [54]. This issue negatively affects the efficiency of blockchain-based healthcare systems, limiting their ability to improve care quality and operational efficiency.

In public data management, the lack of interoperability represents a significant technical challenge. Ensuring that blockchain-based systems can effectively interact with existing infrastructures is important for large-scale adoption [39]. Without common standards, system fragmentation can lead to inefficiencies and hinder collaboration among public entities.

4.2.3. Barriers Related to Perceived Characteristics of the innovation

These barriers are related to user perceptions of the innovation's characteristics, such as complexity, compatibility, and relative advantage. Scalability issues emerge as one of the main technical barriers. Blockchain struggles to manage the vast amount of data generated by public systems, leading to slower transaction times and higher storage requirements [45,55].

In the healthcare sector, the sheer volume of data generated can slow down blockchain systems, especially when processing real-time information. This limits the technology's ability to be adopted on a large scale in sectors that require rapid data processing. In public data management, concerns about data security and privacy can negatively impact the perception of the innovation, hindering adoption [39].

4.2.4. Contextual Barriers

Contextual barriers refer to external obstacles, such as regulations, culture, and social environment. In e-voting, the lack of trust among voters reflects the cultural and social challenges of adopting blockchain technology. Despite the security and transparency guarantees offered, many voters fear that the system could be vulnerable to manipulation or cyber-attacks, undermining participation and trust in the electoral process [56].

Additionally, the absence of a clear regulatory framework represents a significant barrier. The lack of industry-specific guidelines and regulations for blockchain in the public sector creates uncertainty and hampers widespread adoption. Policymakers and regulatory bodies must address legal and ethical concerns, ensure compliance with data privacy regulations, and establish clear standards for blockchain use [37,39,54,57].

In addition to the qualitative synthesis presented above, a supplementary quantitative overview is provided in Figs. A1 and A2, based on co-occurrence patterns identified through content analysis. Fig. A1 presents a heatmap of the estimated number of articles referring to either "Challenges" or "Barriers" in each sector, while Fig. A2 reports the proportion of studies mentioning each barrier type. These visualizations help illustrate the relative prominence of different barriers and highlight sectoral variations—for instance, the prevalence of organizational barriers in education or contextual concerns in healthcare.

4.3. Discussion on main results

Blockchain adoption in the public sector is shaped by a range of organizational, technical, and contextual challenges that vary across application domains. In Table 3, we summarize the types of barriers identified, following the framework from [52], which limit the adoption of blockchain in the public sector, suggesting instruments to overcome specific barriers. The "suggested instruments" reported in Table 3 are synthesized by the authors. They derive from our integrative reading of the cited studies and are organized according to the barrier typology of Cinar et al. [52]. We use them as theory-informed propositions, consistent with patterns observed in the literature, rather than as prescriptions validated by causal evidence. Interaction-related barriers are likely to benefit from interoperable standards, while perceived limitations like scalability or complexity call for further technological development. Contextual constraints, such as regulatory uncertainty or limited trust, suggest the need for broader institutional and societal efforts.

These propositions aim to make the literature's implications operational, but we do not claim causal identification. Future research should test these suggested instruments through comparative and longitudinal evaluations across sectors and institutional contexts to establish their effectiveness and boundary conditions.

Furthermore, the analysis of the literature highlights that each

Table 3
Barriers to blockchain adoption (RQ2).

Category	Specific Barriers	References	Suggested instruments
Organizational Barriers	Resistance to change; lack of technical expertise.	Luthra et al. [53]; Dash et al. [43]; Prux et al. [50]	Training and change management strategies
Interaction-Specific Barriers	Lack of interoperability and standardized protocols.	Rana et al. [54]; Mustafa et al. [39]	Introduction of interoperable standards
Barriers Related to Perceived Characteristics of the Innovation	Complexity, scalability issues, and privacy concerns.	Ali et al. [55]; Clavin et al. [45]; Mustafa et al. [39]	Technological development
Contextual Barriers	Lack of trust and unclear regulations.	Kassen [56]; Abdelhamid et al. [57]; Dhingra et al. [37]; Mustafa et al. [39]; Rana et al. [54]	Institutional policies, regulations

application domain faces specific types of barriers. Table 4 provides a summary of this characterization, aligning each domain with its most commonly associated challenges. Organizational obstacles, especially resistance to change and lack of technical expertise, are pervasive; for example, hospitals may struggle to implement blockchain-based systems due to insufficiently trained technical staff. Among interaction-specific barriers, interoperability issues are the most frequently reported, often requiring the development of technical standards and regulatory frameworks. Scalability concerns are prevalent across nearly all domains, while privacy issues are more prominent in areas involving sensitive personal data,. Finally, contextual barriers are most often linked to regulatory uncertainty or the absence of clear legal frameworks.

At the same time, it is important to acknowledge the methodological limitations of the current literature. Most studies rely on conceptual models or exploratory case studies, which limits replicability and robustness. The literature tends to focus on proof-of-concept implementations in highly digitized countries, which may introduce publication bias and reduce generalizability to less mature contexts. Moreover, outcome indicators are often based on perceived variables - such as adoption intention or user satisfaction - rather than measurable performance improvements. A further indicator of the field's fragmentation is the dispersion of contributions across 33 different academic journals, with no single outlet accounting for more than 10 % of the total. Finally, a technical bias is evident, with limited attention to legal, political, or institutional dynamics.

Nonetheless, recent implementation experiences suggest that many of these barriers can be mitigated under favorable conditions. A growing body of evidence points to enabling factors that support effective adoption. These include technical readiness, inter-agency coordination, and strong governance structures. Estonia offers a particularly illustrative example: since 2012, its national eHealth system has incorporated blockchain to securely manage the medical records of over 1.3 million citizens. This model has improved data traceability, reduced administrative overhead, and increased public trust [40], demonstrating how a supportive ecosystem can transform blockchain from a conceptual innovation into a reliable public infrastructure.

Adoption patterns differ markedly across countries. Administrative capacity, legal frameworks, and institutional trust shape these dynamics. Berg, Davidson, & Potts [59] describe this tension as the "trust paradox": blockchain is most needed in low-trust environments - such as those with unreliable land registries - yet these are precisely the contexts where citizens may distrust governments' ability to implement such technologies effectively. Conversely, high-trust countries may have fewer incentives to adopt blockchain but are better positioned to do so successfully. These dynamics highlight the importance of developing context-sensitive strategies that integrate technological innovation with transparency, institutional capacity building, and civic engagement.

5. Further case studies of blockchain adoption

To enrich the literature review with real-world case studies, this section analyzes key characteristics of blockchain adoption in selected initiatives. The data are drawn from an inventory of 270 blockchain use cases in the public sector, compiled by the European Commission's Joint Research Centre. Although this collection is neither exhaustive nor statistically representative [60], it provides substantial information on organizational features, service characteristics, and implementation status (CEU. JRC., 2022). The database does not report barriers or challenges and therefore cannot be used to validate RQ2; however it offers valuable descriptive evidenceto consolidate main answers to RQ1.

Following the previous analysis, we begin by describing the main application domains of the collected initiatives, as illustrated in Fig. 2. The two primary areas of application are General Public Services and Economic Affairs, which maps closely onto the SLR's most frequent application areas. General Public Services includes many activities related to the Data Management domain discussed earlier in Table 2, and several platforms for e-voting, primarily used for surveys and polls, designed to encourage stakeholder participation in both local and central government. Also this result is consistent with the SLR's finding that formal electoral uses remain limited. In addition, platforms for data

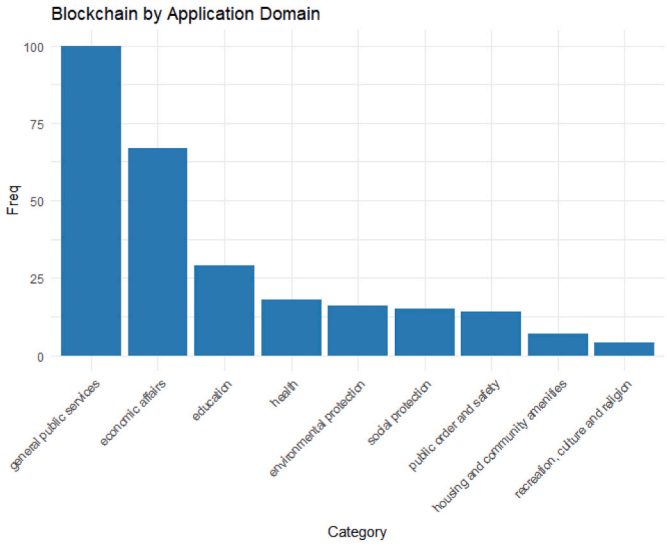

Fig. 2. Blockchain use cases by application domain.

Table 4
Use cases and associated barriers.

Application Domain	*Organizational Barriers*	*Interaction-Specific Barriers*	*Perceived Characteristics of Innovation*	*Contextual Barriers*	References
Healthcare	Resistance to change; lack of technical expertise.	Lack of interoperability and standardized protocols.	Scalability with large volumes of data; privacy concerns.	Lack of trust in blockchain systems.	Luthra et al. [53]; Dhingra et al. [37]; Lu et al. [38]; Mustafa et al. [39]; Rana et al. [54]
Education	Resistance to change; lack of technical expertise.	Interoperability challenges between systems.	Complexity of systems; scalability concerns.	Lack of clear regulations; cultural resistance.	Dash et al. [43]; Tan et al. [42]; Haneem et al. [44]; Rana et al. [54]
Data Management	Limited resources and technical expertise.	Lack of interoperability and integration standards.	Data security and privacy concerns; scalability issues.	Uncertainty in regulatory frameworks.	Lu et al. [38]; Mustafa et al. [39]; Du et al. [46]; Clavin et al. [45]; Anyanwu et al. [47]
Public Finance	Lack of awareness; resistance to change.	Integration difficulties with traditional systems.	Security and trust in financial systems.	Unclear regulations; public trust issues.	Radynskyy et al. [48]; Hung [49]; Prux et al. [50]; Kassen [56]; Abdelhamid et al. [57]
E-voting	Resistance to change.	Non-interoperable systems.	Scalability issues; privacy and security concerns.	Lack of voter trust; unclear legal frameworks.	Clarke et al. (2023)[58]; Verma & Sheel [40]; Kassen [56]; Rana et al. [54]

sharing, internal management, and procurement are also classified under this domain.

The Economic Affairs category encompasses various financial applications, mainly related to payments and international transactions. It also includes systems for goods tracking, copyright management, and data registration or notarization. Finally, the domains of Education and Health also emerge in the analysis, in line with previous findings from the literature review.

This cross-walk confirms the SLR's main domains, but it evidence also few minor areas (e.g., environmental protection, social protection, public order) that are rarely discussed in the literature but appear in practice, suggesting topics for future inquiry. A comparison between SLR results and the case studies analysis is synthetized in Table 5.

Additional insights from the data analysis concern the geographical distribution of blockchain initiatives, the responsible organizations, and their implementation status.

As to the implementation state (Fig. 3), most initiatives are still in the pilot phase (63.7 %), while 46 projects are already reported as implemented. This evidence helps explain occasional misalignments between the SLR (which prioritizes published, implemented activities) and the case inventory (which also lists pilots and planned projects). Notably, about 85 % of implemented cases fall within the domains identified by the SLR for RQ1, reinforcing the external consistency of the literature-derived patterns. In details, in the Health domain, beyond Estonia's well-known e-Health Record, blockchain technology has been implemented during the COVID-19 pandemic for green pass management (San Marino) and cold chain vaccine monitoring (United Kingdom).

In the Education domain, all seven identified initiatives focus on certification and credential validation processes, as it emerged in the literature review.

Regarding the e-voting domain, the database reports four implemented blockchain-based systems—in Russia, Poland, Portugal, and Estonia—used primarily for organizing surveys and polls or monitoring electoral exit polls.

Seven implemented blockchain applications relate to financial services; however, most are designed to provide benefits or discounts to low-income households. Notably, in Poland, a blockchain system was launched to track the sale and distribution of Polish treasury or government savings bonds. Meanwhile, in the municipality of Zermatt, Switzerland, where taxpayers are officially allowed to pay taxes in Bitcoin, local authorities have partnered with one of the country's major crypto financial service providers.

Finally, Figs. 4 and 5 show the distribution of the entire dataset by country and by responsible organization, respectively. A group of countries—including Italy, the Netherlands, Spain, the United Kingdom, and Germany—along with the European Union, appears particularly active in blockchain adoption. Since the data do not result from a comprehensive census, these geographical distributions may reflect differences in data collection systems across countries. While the distribution by country highlights where blockchain-related initiatives are most frequently reported, these figures alone do not account for differences in national policy contexts or levels of institutional trust. Estonia, often cited as a high-trust, digitally advanced country, adopts

Table 5
– Synthesis of comparison between SLR results and case studies.

SLR domains (RQ1)	JRC Category	Typical Implementation in Inventory
Health	Health	Access/audit logs, document trails; supply chain.
Education	Education	Credential issuance and digital identities
Data Management	General Public Services	E-procurement records, data-sharing platforms, notarization/registries
Public Finance	Economic Affairs	targeted benefits, asset tracking, payments
e-Voting	General Public Services	Polls, consultations, exit-poll support (not general elections)

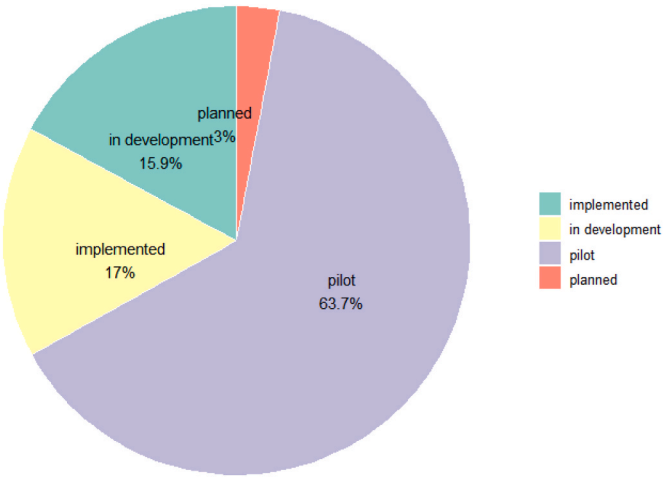

Fig. 3. Blockchain use cases by status.

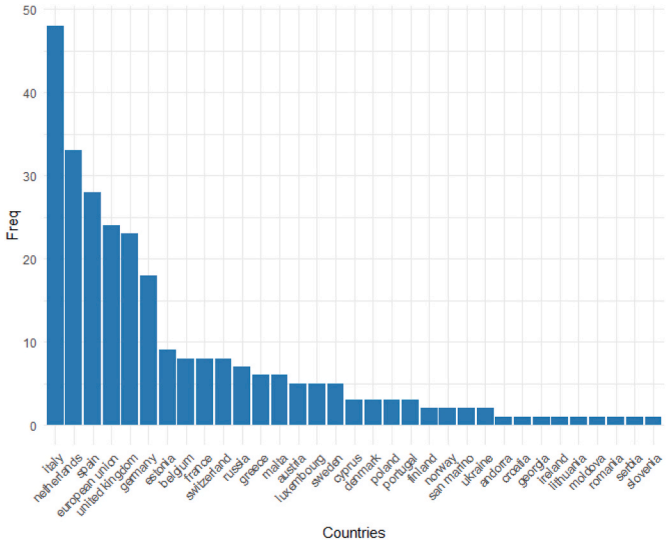

Fig. 4. Blockchain use cases by country.

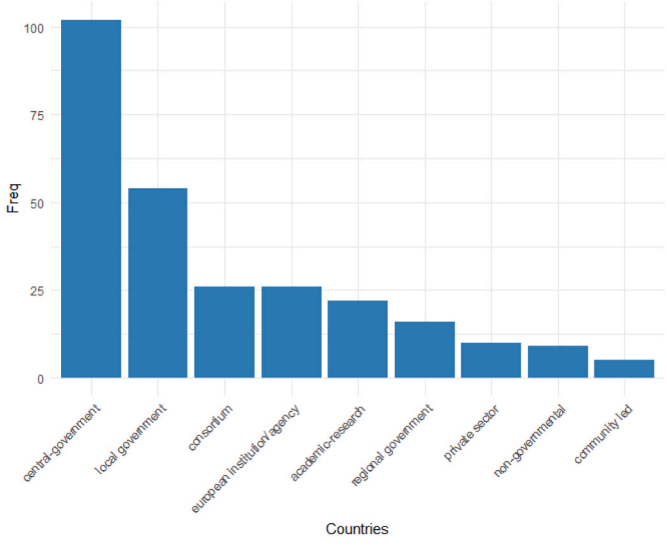

Fig. 5. Blockchain use cases by responsible organization.

blockchain as an extension of its already mature e-governance infrastructure. Here, blockchain reinforces existing trust. In contrast, in countries where institutional trust may be lower or where corruption perceptions are higher, blockchain is sometimes introduced as a compensatory mechanism to increase transparency and traceability. These qualitative contrasts suggest that regional variations in blockchain adoption are not only a matter of frequency but also of purpose and institutional context.

Finally, the most prominent organizations driving blockchain adoption are central and local governments, signaling the relevance of institutional support as enabler in the blockchain adoption.

While the available case studies do not allow for a systematic cross-country comparison of success factors, some recurring enabling conditions can be inferred from the evidence reviewed. These include the presence of strong institutional support, pre-existing digital infrastructure, public-private partnerships, and a clear legal or regulatory framework. In several cases, blockchain adoption was facilitated by limiting its initial use to low-risk administrative tasks—such as surveys, credential verification, or data audit trails—before considering more sensitive applications. These observations are exploratory and should be interpreted with caution, given the variability in data quality and reporting standards across countries. Based on the case studies discussed, some preliminary enabling conditions for successful blockchain adoption in the public sector can be identified, as summarized in Table 6. These factors are not meant to be exhaustive or universally applicable but rather reflect common elements observed in the reviewed examples. They provide a basis for future empirical work on the conditions that facilitate or hinder blockchain implementation in different administrative and national contexts.

6. Conclusions and future agenda

This paper has examined how blockchain technology is utilized across various public sector domains and identified the main organizational and technical barriers hindering its adoption. The responses to our research questions indicate that while blockchain offers substantial opportunities to enhance transparency, security, and efficiency in public services, significant challenges impede its widespread deployment. These challenges vary depending on the context and application area.

Our contribution is to foreground an economic–organizational perspective on public-sector adoption, to synthesize evidence from 37 peer-reviewed studies, and to integrate a data-driven thematic analysis with a qualitative appraisal of source rigor. Furthermore, the literature review has been complemented through a comparison with real-world case studies, based on a dataset of 270 blockchain initiatives adopted by the public sector in Europe. The findings reveal that many initiatives are still in early development phases, and their application areas suggest a predominantly experimental use in non-core administrative functions. The most notable exception is Estonia's e-Health platform, which stands out as a mature and integrated implementation.

Blockchain adoption in the public sector appears to be in a critical transitional phase, unlike the private sector, where it is advancing rapidly toward technological maturity in specific applications. The SLR and the case inventory indicate that public-sector adoption concentrates on some areas of application, such as auditability, credentialing, notarization, procurement, payments, and tracking applications, with initiatives concentrated in low-risk activities. This suggest a cautious approach to blockchain implementation in the public sector.

The practical implications of our findings are extensive. Effective adoption of blockchain in the public sector requires tailored approaches that consider the unique challenges of each sector. Public decision-makers must recognize that there is no one-size-fits-all solution, and overcoming the identified barriers is critical to fully leveraging the technology's potential. Significant investment in technical training and infrastructure is needed. Developing well-defined regulatory frameworks that address privacy, data protection, and stakeholder accountability is also necessary. Promoting public trust through transparency and education can effectively overcome cultural and social barriers.

At the same time, several limitations constrain what can currently be concluded from the academic literature. For instance, the way public sector projects are reported remains highly heterogeneous and inconsistent. Many articles reference multiple initiatives without standardized naming conventions, making cross-study aggregation methodologically challenging. This points to an important avenue for future research, which should aim to establish more coherent documentation practices and case-based evidence. Similarly, the identification of adoption barriers in this study is based on how they are conceptualized and reported in scholarly literature. Further empirical studies are needed to explore how such challenges unfold in concrete project implementations.

6.1. Towards a research Agenda

Building upon the findings of this review, several avenues for future research emerge, aiming to address existing gaps and deepen the understanding of blockchain adoption in the public sector. Comparative studies between public and private sectors could help identify the distinct barriers and enablers that influence adoption dynamics in different institutional settings, offering insights into sector-specific challenges and strategic responses. In addition, longitudinal research designs may provide valuable perspectives on how public organizations evolve in their use of blockchain over time, offering dynamic insight into the resolution of implementation hurdles.

Overall, the findings provide a coherent answer to the research questions guiding this study. Regarding RQ1, the analysis reveals that blockchain integration in the public sector is concentrated in a limited set of domains - such as healthcare, education, data management, public finance, and e-voting - where implementation remains largely experimental and focused on low-risk administrative functions. With respect to RQ2, the review identifies four main categories of barriers (organizational, interaction-specific, innovation-related, and contextual) that jointly explain the uneven pace of adoption across these domains. The comparative analysis with European case studies confirms that the degree of digital maturity, regulatory clarity, and institutional trust significantly influence how these challenges manifest and are addressed in practice. These insights consolidate the analytical bridge between the two research questions, linking observed implementation patterns (RQ1) to their underlying constraints and enabling factors (RQ2).

A sectoral lens also appears particularly promising. In the field of

Table 6
– Potential enablers for blockchain adoption.

Enabling Condition	Description	Example(s)
Institutional support	Strong commitment from national or local governments facilitates adoption.	Estonia (eHealth), South Korea (e-voting), Zermatt (taxes in BTC)
Digital infrastructure	Existing IT systems and digital governance maturity ease blockchain integration.	Estonia (national digital ID and health systems)
Public-private partnerships	Collaborations with private tech providers provide resources and technical know-how.	Zermatt (blockchain tax payment via crypto firm)
Regulatory clarity or experimental frameworks	Adoption is eased when there is a clear legal environment or regulatory sandbox.	South Korea (pilots in regulated settings)
Use in low-risk or administrative domains	Initial adoption in non-sensitive areas reduces implementation risk and builds institutional trust.	Education (credentialing), local polls, surveys
Stakeholder engagement	Early involvement of users (citizens, employees) enhances acceptance and reduces resistance to change.	Participatory budgeting and consultations in local governments

healthcare, future research could examine organizational models for integrating blockchain into both centralized and decentralized systems, with a focus on data security and interoperability. In the education sector, further work is needed on the development of globally interoperable solutions for academic credential verification, especially concerning standardization and cross-border recognition. When it comes to data management, studies could prioritize the design of technical standards and protocols that enable interoperability between public and private blockchain infrastructures, particularly in areas where multiple platforms must interact. In the domain of public finance, research may assess the role of blockchain in improving budget transparency and investigate the technical feasibility of large-scale deployments in financial administration. About e-voting, further investigation is needed to explore mechanisms for strengthening voter trust in blockchain-based electoral systems, considering diverse legal, cultural, and institutional environments.

Moreover, the human and behavioural dimensions of blockchain adoption remain underexplored. Systematic studies on resistance to change, digital literacy gaps, and other socio-cultural factors could enhance our understanding of how public servants and citizens interact with blockchain-enabled services, and under what conditions adoption is more likely to succeed.

Although blockchain technology offers promising opportunities to improve transparency, security, and efficiency in the public sector, its adoption is conditioned by a complex interplay of organizational, technical, and contextual variables. Advancing research through interdisciplinary collaboration and empirical investigation can support more nuanced, evidence-based approaches, contributing to the effective and sustainable implementation of blockchain in diverse public service domains.

CRediT authorship contribution statement

Angelo Murano: Writing – original draft, Methodology, Investigation, Data curation, Conceptualization. **Bruna Bruno:** Writing – review & editing, Supervision. **Vincenzo Vespri:** Writing – review & editing, Supervision.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.seps.2025.102364.

Data availability

Data will be made available on request.

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