Journal of Innovation & Knowledge 10 (2025) 100746

Contents lists available at ScienceDirect

Journal of Innovation & Knowledge

journal homepage: www.elsevier.com/locate/jik

Comparative analysis of blockchain adoption in the public and private sectors. A technology-organization-environment (TOE) framework approach

Melisa Petra Benchis, Khuram Shahzad *, Sorin Dan

University of Vaasa, Wolffintie 32, 65200 Vaasa, Finland

ARTICLE INFO

JEL codes:
O3
O32
O33
O310
O320
O330
O380
L320
L330

Keywords:
Blockchain adoption
Private sector
Public sector
TOE framework
Comparative analysis
Technology-organization-environment

ABSTRACT

Blockchain technology (BT) can potentially enhance transparency, efficiency, and trust across all domains. However, it remains unclear how the relative adoption of BT between the private and public sectors compares in light of existing studies. This article contributes to the literature by evaluating the adoption process through the technology, organizational, and environmental dimensions of the TOE framework. A comparative research design was employed through 21 semi-structured interviews with participants from the public and private sectors in Finland. The results indicate that challenges to adoption uniformly exist between both sectors in the form of regulatory concerns and misconceptions regarding energy matters, as well as incentives that are directly linked to the sector. The private sector is incentivized to adopt BT for scalability, efficiency, and responsiveness to market demand in light of competitive advantage. The public sector is motivated to adopt BT through transparency and regulatory concerns, although a willingness to accommodate legacy systems in the short term exists so that public services and activities are not interrupted. In addition, our findings highlight the important role of public institutions in BT adoption. Ultimately, both sectors require strong visionary leadership and training to overcome knowledge deficiencies and proof-of-concept studies to reduce uncertainty and reliance on external applications and partnerships. This article contributes to the literature by comparatively highlighting the similarities and differences in this phenomenon. It offers practical and policy-related implications and encourages an industry-specific approach to adoption, cross-industry innovations, and regulatory policies.

Introduction

The increasing awareness and growing interest in digital technologies have put digital transformation at the top of organizational agendas (Hafeez et al., 2025) as organizations seek to develop their innovative digital capabilities (Shahzad et al., 2025a). Emerging technologies such as blockchain technology (BT) play a pivotal role in driving these transformations. BT has emerged over the years as a set of innovations that capture interest and investment across both governmental institutions and private enterprises (Haq et al., 2024; Juszczyk & Shahzad, 2022; Mahula et al., 2025, 2025; Shahzad et al., 2024a; Tan et al., 2022a). BT is a decentralized database that enables secure, transparent, and tamper-proof information to be shared via a distributed ledger system (DLT) (Rodríguez Bolívar et al., 2019). The core attributes of the technology include security, decentralization, and immutability. Its disruptive potential is evident in its ability to replace traditional technologies and processes, leading to enhanced performance, transparency, cost, and operational efficiency (Shahzad, 2020). It evolved into a multipurpose tool applied across industries, including financial systems, digital rights management, and public governance (Kayani & Hasan, 2024; Nakamoto, 2008; Rodríguez Bolívar et al., 2019; Tan et al., 2022a). However, blockchain adoption is far from being a technology, considering its multiple applications. In the private sector, BT is most popular—with effective application—for its operability, transparency, and decreased costs. It is used in supply chains to improve tracking in financial capital markets for increased transaction speeds and decentralized lending opportunities and in the energy market for peer-to-peer trades and decentralized energy grids (Dehghani et al., 2022; Zhang et al., 2024). However, in the public sector, BT is theorized for better governance and better service delivery results (Tan et al., 2022a). Key applications include digital identity management, ensuring secure and tamper-proof records and land registries, providing transparency in

* Corresponding author: University of Vaasa, Wolffintie 32, 65200 Vaasa, Finland.
E-mail addresses: melisa.benchis@uwasa.fi (M.P. Benchis), khuram.shahzad@uwasa.fi (K. Shahzad), sorin.dan@uwasa.fi (S. Dan).

https://doi.org/10.1016/j.jik.2025.100746
Received 16 January 2025; Accepted 27 May 2025
Available online 5 June 2025

property transactions, and voting systems, and offering transparent and immutable electoral processes (Andoni et al., 2019; Tan et al., 2025; Toufaily et al., 2021).

While empirical studies have explored the adoption of BT in both the public and private sectors separately (Cagigas et al., 2023; Rodríguez Bolívar et al., 2019; Shahzad et al., 2024a; Sousa, 2023; Tan et al., 2022a, 2025), comparisons of the adoption processes between the two remain limited (with the exception of Toufaily et al., 2021). This study explores these processes from a comparative perspective, identifying how the technology-organization-environment (TOE) factors differ on the basis of the adoption intention and implementation processes between the two sectors. The significance of evaluating the similarities and differences between blockchain adoption in the public and private sectors comes from different drives and limitations (Rodríguez Bolívar et al., 2019; Tan et al., 2025; Wong et al., 2020).

Our results, supported by triangulation from other research, demonstrate that the private sector prioritizes outcomes such as efficiency, scalability, and competitive advantage on the basis of industry (Andrews et al., 2011; Boyne, 2002). Conversely, the public sector is more concerned with regulatory compliance and transparency, leading to a more reserved approach to adoption and a focus on the know-how process, which is often aligned with existing legacy systems (Boyne, 2002; Osborne, 2006). Therefore, relative to this study, a comparative assessment of the findings provides a clearer picture of the dynamics at play, which is beneficial in the long term for policymakers, executives, and practitioners within their industry, as they need to know how to best adopt BT to suit their specific needs. Furthermore, understanding how adoption differs creates effective government synergy through public-private partnerships that can ensure greater effectiveness of BT knowledge and operational retention within sectors (Toufaily et al., 2021).

This research is grounded in the TOE framework, which is a consistent model of delimitation that examines technological innovation from an organizational viewpoint. While other potential theories such as the diffusion of innovation or the unified theory of acceptance and use of technology only examine the adoption experience from the customer viewpoint, the TOE confines the researcher to a more systematic explanation of organizational, micro, and macro dynamics (Chittipaka et al., 2023; Dehghani et al., 2022). TOE is a fairly utilized framework and has been applied in many relevant studies to investigate blockchain adoption across multiple industries. For example, TOE has been used in supply chain research (Chittipaka et al., 2023), finance and banking (Daidai & Tamnine, 2023; Kayani & Hasan, 2024), enterprise resource planning systems (Awa et al., 2016), and even cross-country studies at the organizational level (Malik et al., 2022). TOE is particularly appropriate for this research because it offers a strong theoretical framework and empirical relevance to the results of prior studies. In addition, it allows for an all-encompassing evaluation of the adoption of BT in both sectors (Malik et al., 2022; Tornatzky & Fleischer, 1990).

Thus, the objective of our study is to explore how the public and private sectors are similar and different in terms of blockchain adoption at the levels of technology, organization, and the environment. Our study contributes to the growing body of research on blockchain adoption by offering a comparative analysis of the specific similarities and differences between the public and private sectors. By leveraging the TOE framework, this research examines how technological, organizational, and environmental factors shape BT adoption in distinct ways across both sectors. In doing so, it advances existing research by identifying common adoption challenges while outlining sector-specific drivers that influence BT implementation strategies. In particular, this study makes the following contributions to the literature: (1) a foundation for building cross-sector collaboration, allowing public and private entities to leverage each other's strengths and collectively address common pain points in BT adoption, and (2) insights into sector-specific adoption strategies, offering recommendations that encourage synergies between government agencies and private enterprises through well-structured partnerships and policy frameworks. Thus, the recommendations focus on regulatory consistency and ease, where pro-blockchain actions exist. Furthermore, a mentality change is necessary to ensure that BT is not perceived as just another disruptive cryptocurrency that consumes excessive energy. The relatively recent discoveries about new energy reserves and new compliance and energy public-private partnerships will legitimize safe, compliant, efficient, and seamless integration of blockchain in the future.

In the public sector, inexpensive pilot programs can validate whether BT can enhance existing transparency, efficiency, and quality of services rendered. These programs serve not only as validation for the feasibility of current services rendered but also as the ideal operating atmosphere for scalability. In the private sector, scalability depends on the buy-in of the institution, thus, management must target training, a focused, near-contextual definition of implementation, and relative involvement in operations to achieve efficiency, stabilization, and data privacy. Moreover, educated implementation requires corrections to misconceptions from within and fostering an intrapreneurial culture to ease assimilation. Ultimately, BT adoption is an organizational change, not just a technological change, via compliance and cooperation. This study sets the trajectory for future studies about the interplay of adopting BT with other emerging technologies such as AI and the IoT. As this technology advances and opportunities for intrafield research yield greater understanding, future legislators, managers, and engineers will be better equipped to adopt it in multiple commercial and governmental arenas.

The remainder of the paper is structured as follows: The following section synthesizes the extant literature, developing a theoretical foundation for our paper. This is followed by a description of our methodological design, including the data collection and analysis approach. We then explain our findings in the results section. Finally, we conclude our paper by discussing our results with existing research and offer theoretical and managerial implications followed by limitations and future research avenues.

Literature review

Blockchain adoption in the public and private organizations

The theoretical phenomenon of distributed ledger technology (DLT) and its practical use for BT, which stems from Nakamoto's work on Bitcoin has exponentially increased academically relevant research on this topic. The literature supports the theoretical foundations of BT with practical applications for business governance and advancements by public regulators. For example, Toufaily et al. (2021) conducted a comprehensive literature review in which the reader can see *'nine streams of research related to blockchain adoption'* (Toufaily et al., 2021, p. 2). These streams include but are not limited to, the postulation of barriers to adoption, privacy concerns, socioeconomic micro/macro, business/governance notions about BT, third-party accommodations of influence, present and future applications of BT, etc., and discuss the external factors that affect the state of BT adoption. In this context, as the use of BT has been more prevalent during the last few years, we can see an increase in more in-depth studies (Haq et al., 2024; Sanda et al., 2022; Shahzad et al., 2024a; Sung & Park, 2021), especially from an adoption standpoint (Zhang et al., 2024).

The private sector was an early adopter of BT, as it dealt with less scrutiny from the legislative system, treating it with flexibility. Later, the focus on blockchain emerged, and it was reoriented to solutions tailored to business objectives. This practical approach has led to various applications across industries and regions (Alhasan & Hamdan, 2023; Asa & Zosu, 2023; Daidai & Tamnine, 2023; Gupta et al., 2024). While earlier research articles focused on blockchain's technical features and design (Akram et al., 2020; Tripathi et al., 2023; Upadhyay, 2020), recent studies have shifted toward exploring its potential to deliver measurable business value, its applications across sectors, and its modeling impact at the organizational level (Abbas & Myeong, 2024;

Rahman et al., 2024; Sharma et al., 2022).

Recent studies have broadened the scope of BT applications from traditional use cases, such as cross-border transactions, data storage, and supply chain traceability (Abbas & Myeong, 2024; Li et al., 2023), to emerging areas, such as renewable energy trading (Cui et al., 2023; Rejeb et al., 2024), decentralized identity management (Yan et al., 2024), the integration of BT with AI for predictive analytics (Ressi et al., 2024), and financial services and identity management (Daidai & Tamnine, 2023; Manzoor et al., 2022; Shahzad et al., 2024a; Wang et al., 2019;). Ejairu et al. compared BT applications in the USA and Africa. In the USA, it leverages BT for streamlined processes through smart contracts, whereas in Africa, the technology inspires trust despite infrastructural setbacks. The recurrent themes, however, are trust creation and enabling collaboration in sectors such as supply chain management (Shahzad et al., 2024a), logistics (Ganguly, 2024), and finance (Daidai & Tamnine, 2023; Kayani & Hasan, 2024). Nevertheless, challenges such as accountability in smart contract failures and security breaches persist (Chu et al., 2023), highlighting the need for risk mitigation frameworks. Adoption disparities further complicate integration, with SMEs facing resource constraints (Clemente-Almendros et al., 2024), whereas larger firms lead adoption efforts (Dehghani et al., 2022). The lack of consistent regulatory frameworks is also a barrier to growth in the areas of finance and healthcare, despite partial solutions such as the EU's MiCA and DORA frameworks (Cappai, 2023; European Union, 2024). In this context, Finland's proactive legal approach demonstrates how regulation can foster innovation, but challenges such as scalability and change management still persist (Sorsa & Salmi-Tolonen, 2021).

The adoption of BT in the public sector has garnered increasing attention as governments seek innovative solutions to keep pace with social changes and scientific advancements in society (Dehghani et al., 2022; Tan et al., 2022a). Xanthopoulou et al. (2023) highlighted that the public sector represents a key area for blockchain applications, with over 200 use cases reported globally by governments and public organizations. Foundational uses include identity verification and authentication, as demonstrated in a 2017 study of Canada's public–private ecosystems, where blockchain systems ensured data integrity across institutions such as banks, healthcare providers, and government agencies (Sung & Park, 2021; Tan et al., 2022a; Wolfond, 2017). Blockchain adoption in the public sector prioritizes governmental obligations, such as centralized identity management, alongside productivity, security, and potential threats (Khalfan et al., 2022; Rodríguez Bolívar et al., 2019). E-governance models incorporating blockchain-based solutions demonstrate improvements in data management, legal compliance tracking, and addressing ethical dilemmas (Kassen, 2024; Mustafa et al., 2024). Additionally, public–private partnerships (PPPs) based on BT provide both parties with the opportunity to achieve their sustainability goals by promoting accountability and citizen-centric frameworks while also emphasizing privacy and compatibility with existing systems (Tafuro et al., 2023). However, regulatory barriers remain, including the General Data Protection Regulation (GDPR), variations in jurisdictions, and general scalability issues (Tan et al., 2022a). Most institutions still operate on legacy systems that require significant updates, whereas bureaucratic structures are resistant to change (Shahzad et al., 2024b, 2025b). Overcoming these challenges demands targeted investments in infrastructure, comprehensive training for civil servants, and the promotion of organizational learning (Irani et al., 2023; Tan et al., 2022a). In this context, Haq et al. (2024) and Kusi et al. (2024) emphasize that leadership plays a critical role in addressing these challenges by identifying competencies in curiosity, understanding technology, and aligning blockchain outcomes with organizational objectives. Leadership that fosters a collaborative, curiosity-driven mindset is vital when initiating and navigating these complexities (Shahzad et al., 2025b).

The public sector's interest in BT stems from its potential to restore and maintain trust in public institutions through decentralization and transparency. Countries are testing BT-related applications for service traceability and public voting (i.e., EtherVote), and most of these applications are effective, although they face some regulatory and ethical challenges, as well as privacy and access equity issues (Abbas & Myeong, 2024; Charlebois et al., 2024; Hossain Faruk et al., 2024; Spanos & Kantzavelou, 2023). Finally, protection from a lack of quality in service procurement can be addressed through transparency powered by BT solutions. This model will create trust in government agencies while diminishing human error (Zhang et al., 2024). However, integration requires financial investments and appropriate legislation to set private and access equity standards.

While some of the prior literature offers insight into intentions to adopt BT, few studies assess challenges for specific industries in a critical fashion. Toufaily et al. (2021) analyzed the challenges and implications of BT adoption via a theory-driven approach, assessing types of blockchain. Dehghani et al. (2022) applied the TOE framework to assess a better understanding of BT adoption across various industries; however, they did not assess how the public and private sectors differ in their drivers of BT adoption. In addition, recent findings by Mahula et al. (2025) acknowledge specific important elements that are only found in the public sector. For example, a motivating intention of leadership is to gain revenue for private sector implementation (Kusi et al., 2024). Therefore, while each of these studies notes the sector-specific situational setting in which BT implementation works or does not work at times, this does not transform into a comparative assessment of how each sector implements it. Thus, our research becomes pertinent, as we offer comparative insights based on a multisector perspective on what elements affect blockchain implementation through the lens of TOE.

TOE framework in the context of BT adoption across sectors

The TOE framework was developed by Tornatzky and Fleischer (1990) and has been widely applied in research as an efficient model for studying technological innovation across various contexts, addressing both the technical and non-technical factors of adoption (Baker, 2011). Scholars agree that, compared with other available frameworks, TOE offers a holistic perspective of technological adoption by not accounting for industry-specific constraints or the size of a specific organization (Awa et al., 2017). In this context, the TOE framework has been widely applied in studies analyzing technology adoption and innovations, including BT research (Awa et al., 2017; Dehghani et al., 2022; Ganguly, 2024; Koster & Borgman, 2020; Suwanposri et al., 2021; Taherdoost, 2022).

The technological context consists of technological equipment, infrastructure, and processes. It focuses on the characteristics of the technology itself, including compatibility (Chittipaka et al., 2023), complexity (Suwanposri et al., 2021) with existing systems, and perceived benefits (Chittipaka et al., 2023). The organizational dimension considers the organizational competence regarding human resources, centralized decisions, formalization of processes, the organization structure, and relations among employees, as well as other internal factors such as top management support, organizational readiness, size, and resources that influence an institution's ability to adopt BT (Awa et al., 2017; Dehghani et al., 2022). The environmental context includes the influence of factors outside the organization's control, such as competitors, the macro environment, regulation, and the level of available technological support. The use of BT is arguably more susceptible to regulatory ecosystems where compliance with laws such as the GDPR or financial transaction standards dramatically alters BT implementation (Awa et al., 2017; Baker, 2011; Haroun et al., 2020).

This article utilizes the TOE framework as a measurement because it allows for the gradual transition from considering private and public entities separately to a blended approach to assessing their adoption processes (Baker, 2011). Furthermore, since each dimension aligns with a distinct variable of the adoption process, it is particularly significant in forming a perspective for comparing the different sectors. The TOE framework supports such an assessment by measuring the adoption

process through the lenses of technology, organization, and the environment. This promotes a sector-specific understanding of the differences and general challenges of a vast potential strategy to what could be necessary for blockchain adoption for future organizations and institutions. In addition, by taking inspiration from the future recommendations of prior research, we consider it an appropriate approach to cover this nuance of the BT adoption process through the TOE framework. We opted to conduct our cross-sectoral study by analyzing the technological, organizational, and environmental dimensions of the BT adoption process. By utilizing the TOE framework, we attempt to establish a structured method of comparison between the determinant factors of the adoption process (Chittipaka et al., 2023; Dehghani et al., 2022; Haroun et al., 2020; Malik et al., 2022; Toufaily et al., 2021).

Methodology

Data collection

Data collection is part of more extensive research that aims to study and explore BT adoption processes and implications within the public and private sectors. The data collection was conducted between 2022 and 2023. The basis of the dataset consists of 21 semi-structured interviews (Roulston & Choi, 2018). We interviewed 11 participants from private sector firms and 10 from public sector organizations operating in Finland and obtained very rich qualitative insights into organizational challenges and opportunities related to BT implementation. Table 1 details the organizations involved and the participants' background information. The data from the 21 interviews reached saturation when the interviews ceased to provide new themes or insights (Fusch & Ness, 2015). We continuously reviewed our data until the entire text was coded according to the relevance of the topic, as we tried to identify if the new interviews would introduce and contribute additional perspectives. After seven to eight interviews in each sector, no significant new themes were identified, and the rest of the interviews only reinforced existing insights, supporting the viability of our sample size (Saunders et al., 2018).

These interviews were conducted in English through Zoom and Microsoft Teams and lasted 40–102 min. Each session was fully transcribed, anonymized for confidentiality, and compiled in a 132-page dataset for analysis. The interview questions were tailored to obtain reflections on participants' experiences in adopting BT, understanding organizational processes, and contextual factors affecting decision-making processes in each sector (Gökalp et al., 2020). To increase the reliability of the data, some interviews were cofacilitated by two researchers, guaranteeing consistent interpretation and capturing a range of responses. By adopting this approach, the study explored the nuanced adoption processes in the public and private sectors, emphasizing their technological, organizational, and environmental contexts as framed within the TOE framework (Baker, 2011).

Data analysis

An abductive approach was performed regarding data analysis considering the TOE framework to explore blockchain adoption in the public and private sectors. MaxQDA software version 2024 (MaxQDA, 2024) was used for the coding process to track and analyze key processes. To ensure inter-coding reliability, we compared the results to assess the consistency in theme identification. Unclarities were addressed through discussions that led to consensus.

The analysis started with a preliminary read-through of the interview transcripts to ensure that the researchers were acquainted with the data. From this, a second reading took place to create codes that would represent the ideas descriptively and thematically regarding the processes of BT adoption. After the coding process reached saturation, we organized the codes on the three dimensions of TOE—technology, organization, and environment (Awa et al., 2017; Chittipaka et al., 2023; Malik et al., 2022)—for each sector (even if there was an overlap of codes). In total, the private sector analysis resulted in 71 codes for Technology, 116 for Organization, and 63 for Environment, whereas the public sector analysis resulted in 75 codes for Technology, 148 for Organization, and 45 for Environment. Distinctions appeared as some codes overlapped across sectors, whereas others were specific to one sector. The codes relating to each category of the TOE framework were paired together via the principles of the Gioia methodology (Gioia et al., 2013). To strengthen our understanding of the results, we checked them against industry reports, policy documents for innovation and development, documents from different organizations, reports, and web pages. This ensured triangulation and alignment with real-world implementation trends (Denzin, 2012). Subthemes of codes in each TOE category were created and then aggregated into themes to create logical visual representations and narratives. This led to the development of a clear and coherent narrative, visually represented in the accompanying diagrams from the results section. The private sector analysis can be summarized in 31 subthemes across 9 themes for Technology. Organizations are summarized as 12 subthemes across 6 themes and 14 subthemes across 7 themes for the environment. The

Table 1
List of participants and their background.

Companies	Participants' Positions	Organization	Duration of interviews
Private sector companies			
Company 1	CEO (1)	Agile software development	87 mins
Company 2	CEO (2)	Energy production	58 mins
Company 3	Project Manager (PM) (1)	Energy production	53 mins
Company 4	CEO (3)	IT services	40 mins
Company 5	CEO (4)	Delivery and installation solutions for marine and rolling stock industries	74 mins
Company 6	Project Manager (PM) (2)	Technology centre	72 mins
Company 7	Board Member (BM)	Education, community, and networking	46 mins
Company 8	CEO (5)	Energy production	54 mins
Company 9	Communication and Branding Manager (CBM)	Business services	63 mins
Company 10	Executive Vice President	Automation, protection, and distribution	56 mins
Company 11	CEO (6)	Supplier of waste-to-value products	54 mins
Public sector organizations			
Organization 1	Developer	Tax administration and revenue Management	102 mins
Organization 2	CTO	Digital identity solutions	54 mins
Organization 3	Chief Ecosystem and Technology Officer	Traffic management and control	45 mins
Organization 4	Infrastructure Director	Public transport, streets, parks, forests, marinas and ports	35 mins
Organization 5	Managing Director	Education material for Finnish schools and legal information. (Legal field)	56 mins
Organization 6	Chief Innovation Officer (CIO)	Social insurance and protection organization	75 mins
Organization 7	Counselor and Head of Public Procurement	Public procurement	46 mins
Organization 8	Main Advisor	Radiation and nuclear safety	57 mins
Organization 9	Public Senior Advisor	Policy projects related to digitalization in the public sector, digital identity, EU blockchain	46 mins
Organization 10	Researcher	Cryptography and security	65 mins

public sector had 18 subthemes across 8 themes for Technology, 18 subthemes across 7 themes for Organization, and 10 subthemes across 5 themes for Environments.

Results

Private sector

As deduced from the coding process (summary in Fig. 1), the private sector is transactional in approach. For the private sector to produce capital, it needs to maximize its resources. On the basis of the data, the adoption of BT is characterized by the enhancement of processes for scalability and order, energy efficiency, and adaptability to the market and customer needs. Private organizations see the potential of BT on the basis of its ability to enhance operational efficiency, data privacy, and competitive advantages. Organizationally, the private sector takes a flexible approach compared with the public sector, which is oriented toward innovation. It promotes a degree of decentralization in decision-making and fosters alignment across departments, enabling the formation of strategic goals. Environmentally, private organizations operate pressured by the competitive market, which forces them to navigate regulatory frameworks while pursuing partnerships.

On the basis of the narrative of the results of the structure of the TOE framework, we organized the data in Table 2, presenting the thematic perspective of the private sector regarding BT adoption.

In the private sector, the technology section of the TOE framework is constructed on the basis of the coupling of codes belonging to the technical side of the innovation process. This section is composed of 71 codes in total, grouped into 30 s-order groups, and further paired into 9 themes representative of BT adoption. At the same time, the frequency of the codes creates a detailed accent on the repeating concepts seen through the interviews. This is why the private sector prioritizes BT's capacity to track inputs, outputs, and processes; privacy and transparency; and adequate integration of the code with existing infrastructure. A unique aspect includes the focus on energy-related applications and the potential that BT has for monitoring and validating data in real-time operations for the energy sector and waste management in Finland. The organizational component within the TOE framework has the highest volume of codes in the private sector, reflecting the internal dynamics, structural challenges, and cultural readiness essential for adopting BT. With 116 codes, 12 subthemes, and 6 themes, this section examines the relationships between employee mindsets, knowledge gaps, leadership vision, decision-making structures, and resource allocation as part of the organizational perspective, with each theme highlighting the organizational nuances that influence the success of BT adoption. The environment section is constructed on the basis of codes that reflect the external influences affecting BT integration. This section comprises approximately 64 codes organized into 14 secondary groups and further categorized into 7 overarching themes that highlight key environmental factors for BT adoption. External influences here include market competition, industry-specific regulatory compliance, and potential collaboration with technology providers. Codes reveal a strong focus on addressing competitive pressures and adjusting to rapidly changing industry trends. The uniqueness of the private sector in this section is the challenge of navigating regulatory requirements and deciding to pursue profitability through BT innovations or deciding to wait for the competition and large players to establish the market.

Public sector

In the public sector, the main driver of BT adoption is the need to optimize the available resources (summary of codes in Fig. 2). In this section, the adoption process is characterized by public service quality, system updates, compatibility, intensive planning, technical know-how development, regulatory compliance, and interagency collaboration. At the same time, in the case of the public sector, society holds them accountable for the implementation of this technology; hence, the priorities of transparency, stability, and alignment with the existing infrastructures strongly resonate. Top-down decision-making and C-suite involvement are highly visible, so blockchain initiatives need to align with the mission and tasks of the public sector.

On the basis of the narrative of the results of the structure of the TOE framework, we organized the data in Table 3, presenting the thematic perspective of the public sector regarding BT adoption.

Similarities and differences in blockchain adoption between the private and public sectors

This section presents the similarities and differences between the two sectors via the structural lenses of the TOE framework. As the framework

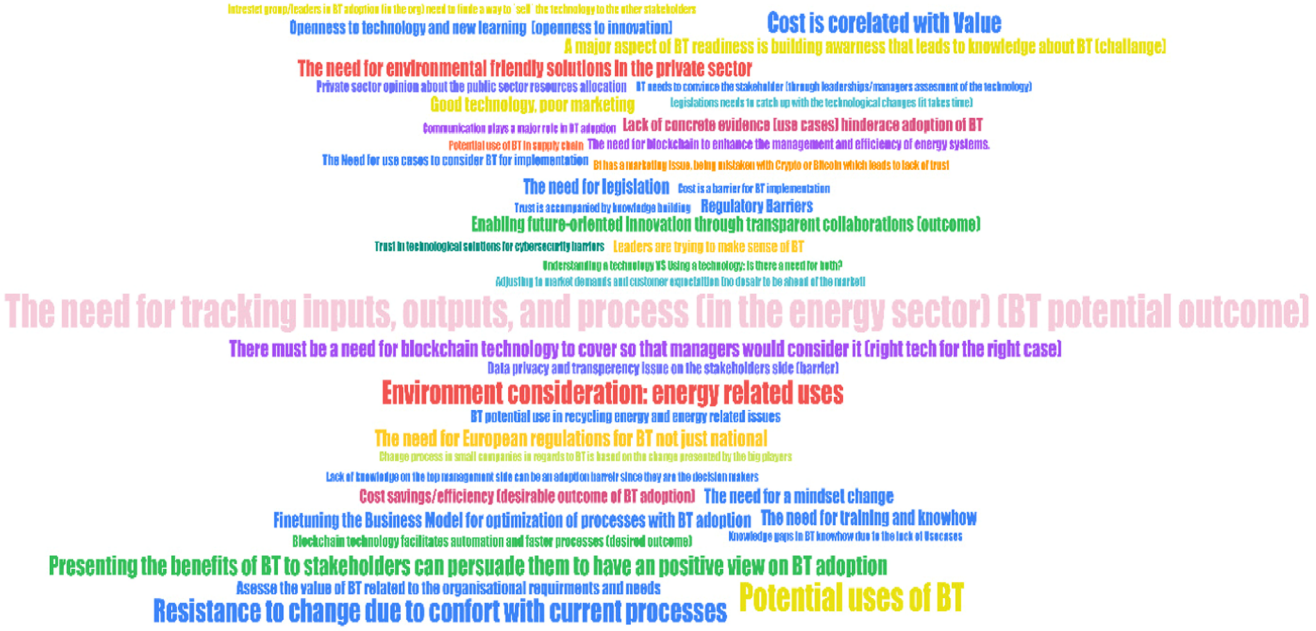

Fig. 1. Private sector codes frequency—Codes cloud.

Table 2
Private sector - TOE framework on themes.

TOE Factor	Themes	Sub-themes
Technology	Implementation readiness and technical barriers	• Infrastructure and Resource Limitations • Technological Readiness and Maturity • Time Constraints and Implementation Challenges • Evaluation and Compatibility • Transition and Integration Requirements
	Privacy, security, and trust concerns	• Data Privacy Concerns • Security and Cybersecurity Measures • Trust and Data Sharing Complexity • Protocol and Cost-Related Concerns
	Cost and financial impact	• Cost as a Barrier • Value and Cost Efficiency • Return on Investment and Value Generation
	Energy consumption and environmental impact	• Potential Use Cases of Blockchain Technology (BT) in Energy • Energy Concerns as Barriers • Marketing and Awareness Challenges
	Use cases, application potential, and practical benefits	• Industry-Specific Applications • Data Storage, Verification, and Accessibility • Process Automation and Operational Efficiency • Financial Transactions and Tax Applications • Pilot Testing and Implementation Challenges • Theoretical vs. Practical Use Cases
	Transparency and accountability enhancements	• Transparency in Data and Communication • Security and Accountability • Organizational Impact
	Marketing, perception, and knowledge barriers	• Misconceptions and Associations with Cryptocurrencies • Lack of Proof and Concrete Use Cases • Marketing and Communication Challenges
	Technological compatibility and integration challenges	• Importance of Digital Infrastructure • Business Model Optimization
	User experience and interface design	• User-Friendly Interface Development • Usability and Profitability
Organizational	Resistance and mindset challenges	• Resistance to change • Mindset and perception barriers
	Knowledge gaps and training needs	• Training and educational initiatives • Awareness and knowledge building
	Leadership and strategic vision	• Leadership's role in adoption • Strategic vision and goal alignment
	Stakeholder engagement and communication	• Communication as a tool for adoption • Stakeholder persuasion and buy-in
	Organizational structure and decision-making processes	• Organizational dynamics and decision-making • Internal collaboration and process optimization
	Motivation, learning, and resource allocation	• Motivation and openness to learning • Resource availability and allocation
Environmental	Regulatory and legislative environment	• The Need for Legislation and Policies • Political and Social Influence on Regulation
	Resource allocation and financial investment	• Funding and Financial Support • Human Resources and Knowledge Development
	Market and competition dynamics	• Market Relevance and Competitive Landscape • Customer Expectations and Relationship Management
	Environmental and sustainability considerations	• Energy and Environmental Impact • Sustainable Innovation and Social Impact
	Collaboration and networking	• Collaboration with External Partners • Knowledge Sharing and Industry Influence
	Risk management and security concerns	• Managing Risks and Threats • Pilot Projects and Incremental Adoption
	Temporal and contextual factors	• Transition and Adoption Timeline • External Factors Affecting Adoption

was used to establish the lenses through which we regarded the adoption process of BT in both sectors independently, it is now the unifying spine of the data, and it helps with creating a structure of comparison. This approach can allow the reader to better understand how the sectors navigate the challenges and opportunities they encounter and what the relationship is between the private and public sectors regarding BT. Therefore, this comparison is meant as an assessment guideline for the sectors so that they can pinpoint the grounds on which to build partnerships and the rationale behind them. These comparisons are also an assessment of the unique points that differentiate them in terms of value generation.

Similarities of the BT adoption process in the private and public sectors

The similarities in these sectors are marked by shared goals for both sectors, despite the different organizational contexts. The common points were identified in the challenges the sectors are facing while trying to implement BT and the common general approach for adoption. By using TOE on the coded data, we observed that both individual sectors follow a similar structure of thinking in the process of BT adoption while making the action plan personalized to the needs of each sector.

Technology (T). Both the private and the public sectors acknowledge the technical potential of BT as a tool that can improve the transparency of data. This feature is deemed to improve communication between departments and reduce silos, which would create efficiency in the process reliant on the data reports. This characteristic is paired with BT's ability to enhance security for both sectors, making it difficult for individuals working inside or outside the organization to tamper with the data owing to the traceable unique record. Both sectors agreed that this characteristic would enhance trust between different stakeholders and build accountability. In the private sector, this aspect would create credibility and trust for the clients and would boost trust with shareholder partners. For government agencies, the characteristics align with the mission of maintaining transparency between civilians and businesses alike.

Both sectors require an assessment of the level of compatibility, applications, and risks of the technology with the organizational scope.

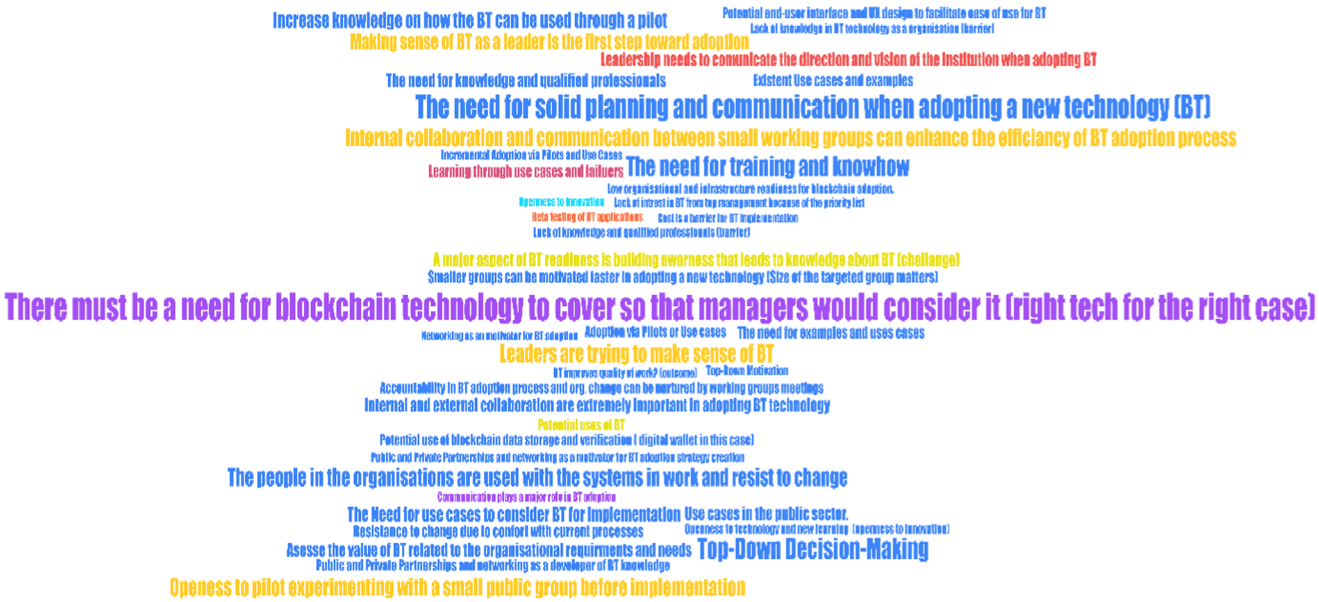

Fig. 2. Public sector codes frequency: Codes cloud.

Managers of both sectors need to make sense of BT when presenting it to stakeholders/government officials. This assessment helps managers hold their case for the need to adopt BT in front of top management to make their overall decision. The interviewees explained that the positive decision to adopt BT is also correlated with the distributed size of the organization.

Integrating BT into already established systems may lead to complications in both contexts. Both sectors face compatibility issues in terms of current infrastructure. The public sector emphasized a greater need for system updates than did the private sector, but the problem persisted in both scenarios, adding up to the implementation costs. This challenge often involves legacy systems and would require, in both cases, extensive planning and technical adaptation so that the interface would be available to organizations and, at the same time, their clients, customers, and suppliers (the need for a double work interface). In the private sector, we have the example of a nuclear energy system and the need to update old systems. Moreover, the public sector stressed the need for incremental adoption from old systems to a BT system, prioritizing a structured plan that would ensure that BT is integrated without service disturbances. Similarly, for both sectors, as articulated in a handful of entries, there is also a need for use cases and pilot testing to minimize potential risk and failure when adopting BT at a larger scale, especially for the public sector. Both types of leaders (from the private and public sectors) recognize that this would be an effective way to adopt the technology and reduce change resistance at an organizational level.

A final notable technological similarity is the shared concern for the environmental impact of BT due to energy consumption. This aspect has its roots in the common misconception that both sectors exercised, to some degree, in associating BT with Bitcoin (cryptocurrency). Because of BT's poor word-of-mouth marketing in terms of sustainability and limited research initiatives by organizations, BT is seen as a high-energy-consumption technology by managers and leaders, which inspires skepticism in adoption decisions. Both the private and public sectors have sustainability goals in mind; therefore, they seek technical solutions that align with broader environmental objectives, making the responsible use of energy a priority.

Organizational (O). On the basis of the organizational section of the TOE framework, the most important similarity between the sectors is the need for a visionary leader who would drive forward the BT adoption process. The interviewees mentioned that such leaders and managers are required to communicate the value of BT and to strategically guide its implementation in terms of resource allocation, employee engagement, and adoption initiation. The data on leadership state that BT projects with lower organizational resistance succeeded when the employees were put under less pressure. In one project, for example, the process was regarded as a secondary project. It made the task seem minor to the employees. Employees, therefore, work without panic or fear, resulting in minimal resistance to change. This would, therefore, imply that employees remained productive when the leadership downplayed the pressure and importance of a project, which decreased resistance.

Another organizational need recurrently identified in the datasets has been the need for training and knowledge development. Both sectors face gaps on the technical front that may stir organizational resistance (higher resistance in the private sector than in the public sector). Training programs are essential to build internal know-how and provide employees with the required skills, be they employees on the back end or employees and clients on the front-end side.

The accountability of employees, as a form of performance monitoring by both sectors, is again sought. It also relates to the need to have a small group that would test the aptitudes of BT in a pilot project. This means that both sectors want to ensure that BT projects meet the expectations of stakeholders and create value in terms of efficiency, quality, and return on investment quality. From a collaborative perspective, both sectors would desire the removal of silos between departments, which is why maximizing internal communication, supportive knowledge sharing, and collaboration during a potential change process was an important aspect for the interviewees. Because of the need to achieve enhanced cooperation during organizational change, some interviewees mentioned that their role as leaders would be accentuated in terms of engaging, encouraging and monitoring, and providing feedback to employees in a mentoring manner.

Environment (E). The environmental similarities between the private and public sectors highlight the complexity of the policies and regulatory reality that impact blockchain deployment and capacity for scalability. In this context, both sectors are aware and agree that financial regulations, data privacy, and security values need to be maintained at high standards; even so, the common agreement is that the legislative context is not adapted to the new technological landscape resonating through the market, both at the national level and the European level.

Table 3
Public sector - TOE framework on themes.

TOE factor	Themes	Sub-themes
Technology	Adoption readiness and technical feasibility	• Infrastructure and Readiness • Technology readiness is positive in terms of technology • Pilot Testing and Incremental Adoption
	Security, privacy, and data management	• Privacy and Data Transparency • Security and Trust
	Cost and financial viability	• Cost Barriers and Savings Potential • Economic Justification and Efficiency
	Practical applications and use cases	• Potential and Desired Outcomes • Functional Applications and Utility
	Technological challenges and constraints	• Technical and Knowledge Barriers • Implementation Uncertainty and Readiness
	Scalability and Long-Term Viability	• Scalability and Future Integration • Adaptation to Market Trends and Needs
	Flexibility and modularity	• Adaptable Use Case Models • Iterative Learning and Practical Adjustments • Strategic Focus and Vision
	Policy, compliance, and regulatory adjustments	• Infrastructure and Collaboration • Research and Problem-Solving Focus
Organizational	Leadership and decision-making	• Visionary and Results-Oriented Leadership • Top-Down vs. Distributed Decision-Making
	Training, knowledge, and skills development	• Education and Knowledge Building • Learning Through Practical Application • The need for knowledge and qualified professionals • Leaders are trying to make sense of BT
	Communication and collaboration	• Internal and External Collaboration • Effective Communication for Change Management • Leadership Development and Guidance • Collaboration and Teamwork
	Motivation, rewards, and employee engagement	• Incentives and Motivation • Employee Engagement and Empowerment
	Overcoming resistance and change management	• Addressing Resistance to Change • Adapting Organizational Mindsets
	Accountability and performance management	• Accountability Structures • Performance Monitoring and Evaluation
	Practical implementation and knowledge application	• Utilizing Use Cases and Examples • Practical Application and Innovation
Environmental	Partnerships and collaboration	• Public-private partnerships and Networking for Knowledge Development • Cross-Sector and Organizational Collaboration
	Legislation, regulation, and accountability	• Need for Legislative and Regulatory Frameworks • Ethics, Accountability, and Compliance
	Citizen engagement and education	• Raising Public Awareness and Understanding • Social and Cultural Considerations
	Resources and collaboration	• Financial and Human Resource Investment • Infrastructure and Local Expertise
	Technological fit and market relevance	• Adaptation and Scalability for Market Needs • Barriers and Challenges in Adoption

This puts a hold on the implementation process of BT, especially for the private sector, when doing interagency collaborations inside the Eurozone with clients potentially interested in DLT. The height of government policies also heavily depends on public organizations, where interagency collaboration is often mandatory. For the sector, this creates a robust but rigid framework that ensures stability at the expense of innovation in the case of BT adoption. Partnerships between the public and private sectors, as well as networking, are also accentuated. The interviewees emphasized, on both sides, the need to facilitate knowledge sharing and BT expertise that would encourage supportive regulatory frameworks. Both sectors discussed that recurrent and lasting collaboration with different organizations would create a pool of resources that would reduce adoption barriers and help them gain insights and experience in the BT adoption process (the private sector emphasized specialists in BT, whereas the public sector referred to the private sector and investments in academic research and educational curricula on the subject).

Through this narrative, we can conclude that even if BT is tailored to the specific needs of each sector in practice, both share specific challenges, risks, and priorities that offer them a degree of similarity. In the context of blockchain adoption, these mentions could be building blocks for encouraging the two sectors to further develop their communication and collaboration initiatives. Table 4 provides supporting quotations from the respondents.

Differences in the BT adoption processes in the private and public sectors

The private sector and the public sector approach are shaped by distinct operational structures and expectations in terms of regulations. These characteristics influence the strategy models for both organizations in terms of value creation alignment, resistance to change, and the methods of implementing those strategies.

Technology (T). The technological differences between the sectors became visible during the assessment that the interviewees made regarding the infrastructure readiness of the organizations. The public sector mentioned often outdated infrastructure systems, some dating from 20 to 30 years ago, depending on the department or area of public administration. In this context, the public sector's main concern is related to carefully measuring the compatibility of BT with the legacy systems of government operations, which now act as a governmental backbone that is trusted by both civilians and employees.

This compatibility and the need for incremental adoption are required to ensure that the potential transfer of data and activities does not disrupt the public services that are essential to day-to-day activities and processes. Therefore, blockchain adoption in the public sector is characterized by a more cautious approach and a risk-averse mindset. Managers and employees delegated to such projects would need to test and evaluate the effectiveness of the technology repetitively and to ensure that beta testing is leanly adopted on a larger scale. In parallel, the private sector is oriented toward the need to optimize the operational efficiency of the business. This sector views BT more as a tool that could help with the high-demand real-time tracking of products and privacy management than an entire system. Its main outcomes focused on helping with scalability actions (where the size of the business requires it) and, most importantly, profit generation owing to its flexible

Table 4
Similarities of BT adoption process in the private and public sector.

Similarities	Private sector	Public sector
TECHNOLOGY DIMENSION		
Improves transparency and reduces silos in organizational processes	Blockchain makes the verification processes automatic and reduces human involvement in tasks like certificate validation, leading to more efficient workflows. (CEO (3))	Blockchain enables centralized, role-based access to information, eliminating data fragmentation across multiple databases. (Main Advisor)
Enhances data security and accountability by making records tamper-proof	Blockchain safeguards sensitive business data, ensuring that records cannot be altered or tampered with. (Executive Vice President)	Blockchain enables secure digital credential verification, allowing authentication without direct communication between parties (CTO)
Requires assessment of compatibility, applications, and risks within the organizational scope	Blockchain adoption must align with specific business applications (e.g., supply chain, fintech) to ensure feasibility. (CEO (1))	Public organizations must first define the blockchain's purpose and objectives before implementation.
Requires pilot testing and use case evaluation to minimize risks during adoption	Businesses conduct dry runs to test blockchain functionality before full implementation, ensuring smooth transitions. (CEO (1))	Public organizations initiate pilot projects to assess feasibility before large-scale deployment, particularly for complex ecosystems like digital payments. (CIO)
Concerns over environmental impact and energy consumption, partly due to association with cryptocurrency	Blockchain is often perceived negatively due to its high energy consumption, particularly from cryptocurrency mining. (CBM)	Many blockchain networks are seen as unsustainable and not aligned with green energy initiatives. (CTO and CIO)
ORGANIZATION DIMENSION		
Visionary leadership is essential for driving adoption and guiding strategic implementation.	Leadership must be flexible and adaptive to drive blockchain adoption and navigate technological change. (BM)	Strong charismatic leadership is needed to advocate for decentralized business models and push blockchain initiatives forward. (Public Senior Advisor)
Training and knowledge development are necessary to address technical gaps and reduce resistance.	Blockchain adoption requires internal training and strong communication to highlight its business value and profitability. (CEO (6))	A combination of hiring, training, and hands-on experimentation is key to improving blockchain capabilities. (Managing Director)
Pilot projects are important for testing aptitudes and reducing organizational resistance.	Small-scale pilots help businesses find risks, validate feasibility, and secure stakeholder buy-in before full-scale deployment (CEO (2)	Pilot projects allow public organizations to test blockchain solutions with minimal resistance before institutional adoption. (Main Advisor and Public Senior Advisor)
Collaborative approaches to remove silos between departments and maximize knowledge sharing	Businesses often rely on external partners for blockchain expertise rather than building in-house teams. (CBM)	Overcoming departmental silos and fostering inter-team collaboration is essential for effective blockchain adoption. (Managing Director)
ENVIRONMENTAL DIMENSION		
Policy and regulatory complexities affect blockchain's deployment and scalability.	The lack of clear regulations slows adoption, as the legal framework is often behind technological advancements. (PM (1))	Standardization and compliance challenges make large-scale blockchain implementation difficult, requiring updated regulatory frameworks. (Researcher)
Legislative gaps limit blockchain's scalability and inter-agency collaboration.	Blockchain adoption needs EU-wide regulations to enable interoperability and prevent legal inconsistencies. (CEO (6))	Regulatory uncertainty and legal barriers prevent seamless collaboration across public agencies and limit blockchain's scalability. (Public Senior Advisor)
Partnerships and networking are critical for knowledge sharing and reducing adoption barriers	Strong industry collaboration helps businesses understand customer needs and improve adoption. (CEO (2))	Government organizations must collaborate with the private sector to align blockchain implementation with legal and operational requirements. (CE&TO, CTO and Public Senior Advisor)

solution designed to meet evolving operational demands.

Organization (O). On an organizational level, the differences are noticeable even when the number of codes used between the two sectors is compared. Both the private and the public sectors presented the highest number of codes per sector in the organizational section of the TOE framework. This finding highlights the importance of the organizational component when trying to implement an innovative tool or process, regardless of sector. Even so, the amount of coded data in the public sector exceeds that in the private sector, accounting for approximately 20.70 % of the entire list of organizational codes (100 %). This signals a slightly greater importance of the organizational factor in the public sector.

When appreciating the differences between the two sectors, the first indicator is represented by the leadership methods. The public sector mainly follows a 'top-down' model in approaching innovation. In this sector, leadership and management are centralized, and they guide the decision-making process to ensure that potential blockchain adoption aligns with the broader mission of public services, transparency standards, and ethical standards across departments. Communication and collaboration are integral in the public sector's approach. They are necessary for the extensive planning involved in introducing BT as a new data management system at such a national scale. In contrast, the leadership methods in the private sector are a mix of centralization and decentralization based on company size. Smaller companies have a more decentralized approach to leadership and management, proposing even a 'bottom-top-middle' approach or 'middle-top-bottom' approach in blockchain adoption. This allows flexibility and encourages an innovation-driven culture. The management of organizations in the private sector encourages individuals and departments to explore the potential of BT independently within the goals of the company. Training, in addition to knowledge development, is another important differentiator. In the public sector, training and educational programs are oriented toward compliance and ethical data management due to the sector's emphasis on transparent service to the public. It also shows greater tolerance for experimentation if the technology proves to have a real application in specific governmental contexts. In turn, the private sector focuses on training that outlines potential applications that drive efficiency, monitor performance, and enhance an organization's ability to generate value and profit. The value, in this case, is linked to the costs and return on investment.

Another difference between the two relates to risk management and accountability. Blockchain adoption projects are highly dissected in the public sector to ensure that they conform with governmental regulations and ethical guidelines. Therefore, in the public sector, risk management needs to offer an in-depth level of analysis and regulatory oversight to

gain credibility and trust. The careful approach ensures that BT is fully compliant with all guidelines set by the government before being widely adopted. The private sector approach is, in turn, very flexible and responsive; therefore, risk management is based on competitive advantage and the needs prevalent in the market.

Differences also appear at an organizational alignment level. The public sector often faces conflicts between individual and organizational goals that may result in resistance to change. In the private sector, employee goals are more harmonious with organizational goals since they contribute to change and have a say in the processes of the company. This is further supported by the availability of performance-based incentives that act as motivators toward the assimilation of new technologies.

Environment (E). Environmental differences present separate types of dynamics in legislative constraints, as well as visible differences in how the market influences adoption in the two sectors. The adoption of blockchain in the public sector is policy driven and bound to influence regulations. This is why ensuring long-term stability for citizens and accountability for public workers is necessary. The interviewees expressed that blockchain initiatives in the public sector must strictly follow government frameworks and emphasize interagency collaboration.

On the other hand, the private sector works in a flexible competitive environment, balancing regulations with the need for innovation. The adoption of BT has become an opportunity and boundary that has driven market differentiation. Along with the tech providers, the objective is toward profitability and adaptability. Therefore, companies can use BT for strategic advantages without waiting for comprehensive legislative approval, even if it is desired. The important distinction here is regulatory flexibility, where the public sector waits for the guidelines to become clear and the private sector influences what guidelines will be and adjust to existing ones. Accountability also differs. Public organizations are responsible to the public, which creates conservatism and slightly leans toward the need for adaptability rather than being innovative, whereas private firms are controlled by corporate governance with latitude to innovation. In short, blockchain usage in the public sector emphasizes stability, ethics, and service to the public, whereas in the private sector, scalability, efficiency, and market responsiveness focus on leveraging BT for competitive advantage and agility.

Ethics and accountability standards differ as well. While public sector organizations adhere to strict ethics and accountability measures, the scrutiny of the media and the public dictates a conservative approach to the adoption of blockchains. Private organizations still fall under corporate governance and industry regulations, are held accountable under a different structure, and allow for a greater margin in maximizing strategic value through new technologies. Another critical difference in the adoption of blockchain is financing. The public sector is constrained by the financing available, basing itself on government-sponsored investment and raising public awareness for step-by-step adoption through education and citizen outreach. In contrast, much greater resources are available to the private sector (based on the forecasted cost) for rapid deployment driven by competitive pressures and market trends, which enables rapid scaling for companies to capitalize on the strategic use of BT.

The whole approach of the public sector toward BT, therefore, features a structured stability-oriented strategy motivated by the need to integrate with the legacy system while maintaining centralized leadership and observing strict regulatory requirements. Here, blockchains are cautiously adopted, emphasizing reliability, ethical standards, and a commitment to public service objectives. On the other hand, in the private sector, the significant guidelines are scalability, good organization of operational activities, and response to the market. Here, BT is used in an attempt to centralize responsiveness, output, and favorable positioning on the market. In this fast-paced, profit-driven world, BT is utilized by private organizations for differentiation and adaptability to the moving trends of regulation and the market to allow for an easy plunge into the market and thereby achieve a strategic advantage in competitiveness. Table 5 provides support quotations from the respondents.

Discussions

The research direction of this paper focused on offering a comparative analysis of the adoption similarities and differences between the private and public sectors when discussing the process of BT adoption. To present a structured comparison of our 21 qualitative interviews, we followed the TOE framework, which is used as a tool that describes the context in which factors influence the adoption decision of innovative technology. We offered an in-depth analysis of the three perspectives of adoption, namely, technology, organization, and environment.

From a technological perspective, both the private and public sectors recognized that BT has a general technical advantage in terms of record keeping, efficiency, and transparency, yet their differences appear clear when we look at infrastructure readiness and the pace of potential adoption. The private sector focuses on profit generation and productivity as core value added, and it remains customer-centric and competition-focused. Moreover, the public sector prioritizes compatibility with institutional systems, the quality of services offered to citizens, scalability issues in terms of implementation, and public accountability (especially media).

From the organizational perspective, companies are more flexible in the adoption process than public institutions are. In the private sector, the decision-making process may encourage employees' participation in the innovation process, and they may align stakeholders' goals with organizational objectives. In contrast, the public sector requires more structure and is driven mainly by a top-down approach to ensure that BT initiatives are implemented following the missions of institutions, existing regulations, and ethical practices. This may lead to a divergence of the employee's personal goals and the institutional perspective, adding to the resistance encountered in change. We re-establish the critical role of leadership, training internal collaboration, and piloting, as highlighted by both sectors. Even so, in this respect, the private sector approach is more responsive to market demands. However, the public sector emphasizes structured planning and careful execution for the betterment of citizens.

From an environmental point of view, private sector operations are influenced by competition in the market and the current trends in innovation. There are needs for and considerations of regulatory aspects; however, the perspective is more flexible, with the private sector focusing more on innovating than conforming, believing that their practice can aid regulatory bodies in solidifying legislation (national and EU). Moreover, we discovered that the public sector faces more rigid legislative regulations due to the public nature of institutions. This sector requires interorganizational collaboration, public–private partnerships, and citizen engagement to maintain transparency and ethical adoption of this technology. Despite these differences, both sectors share energy consumption, regulatory uncertainty, and the need for research and pilot projects to be mindful of the risks.

We argue that the TOE framework provides a structured foundation when trying to make sense of BT adoption. However, it is important to add that the sectoral context plays an important role in molding the relevance of each dimension in the framework. In the public sector, the environmental variable (regulations and requirements compliance) has a greater influence on the adoption decision than does the private sector, where the most important variable is organizational (organizational readiness and cost–benefit analysis). This aspect emphasizes the need to extend TOE applications by incorporating institutional legitimacy factors, particularly in government-driven blockchain initiatives. In summary, our results show that BT introduces new considerations not explicitly covered in TOE, such as energy consumption concerns and

Table 5
Differences in the BT adoption process in the private and public sectors.

Differences	Private sector	Public sector
TECHNOLOGY DIMENSION		
Approach to Adoption	Focuses on optimizing operational efficiency and scalability. Prioritizes efficiency, scalability, and economic benefits, aiming for seamless automation and faster transactions. (CEO (2))	Adopt cautiously, prioritizing service continuity. (CTO)
Infrastructure readiness	Uses more modern systems but still faces integration challenges. (PM (1))	Often relies on legacy systems, requiring careful compatibility checks. (Main Advisor)
Risk management during adoption	Relies on real-time tracking and privacy management for profit. (Executive Vice President PM (1))	Requires repetitive testing and evaluations to ensure stability. (CIO and Main Advisor)
Energy efficiency concerns	Seeks cost-effective, energy-efficient blockchain solutions. (CEO (6))	Focuses on incremental adoption aligned with environmental objectives. (Main Advisor)
ORGANIZATION DIMENSION		
Leadership style and management	Uses a mix of centralized and decentralized leadership, encouraging an innovation-driven culture. (CEO (3))	Follows centralized, top-down leadership for alignment with public service goals. (Public Senior Advisor)
Training focus	Prioritizes profit-oriented applications and efficiency training. (CEO (6))	Emphasizes compliance, ethical standards, and service delivery. (Counselor and Head of Public Procurement)
Resistance to change	Employees are more likely to align goals with the organization due to incentives. (CBM)	Higher resistance due to conflicts between individual and organizational goals. (Managing Director)
Risk management approach	Flexible and market-driven, focusing on competitive advantage. (PM (1) and BM)	In-depth, regulation-bound analysis to ensure compliance. (Public Senior Advisor)
Pilot project implementation.	Focused on scalability and return on investment. (CEO (3))	Focused on minimizing risks and service disruption. (CTO)
Alignment of goals	Goals often harmonize due to performance-based incentives. (CEO (1))	Conflicts arise between individual and organizational goals (Managing Director)
Internal collaboration and communication during the adoption	Encourages independent departmental innovation (CEO (3))	Relies on extensive planning and inter-departmental cooperation. (Director and Counselor and head of public procurement)
ENVIRONMENTAL DIMENSION		
Regulatory influence	Balances innovation with flexible interpretation of regulations. (CEO (2))	Heavily constrained by strict regulatory frameworks. (Public Senior Advisor)
Policy dynamics	Influences regulations through market activity. (CEO (6))	Waits for clear regulatory guidelines to act. (Researcher)
Accountability	Governed by corporate governance with strategic flexibility. (BM)	Strict accountability to the public, limiting flexibility. (Researcher)
Ethics and scrutiny	Less scrutiny, allowing innovation for strategic advantage. (CEO (6))	Faces higher public and media scrutiny, enforcing conservative approaches. (Counselor and Head of Public Procurement)
Financing and resource allocation	Flexible and competitive resource allocation for rapid deployment. (CEO (1))	Relies on government-sponsored investment and gradual funding. (Developer)
Collaboration emphasis	Collaborates with tech providers and specialists for strategic gains. (BM & CEO (1))	Collaborates with academic institutions and private firms to build capacity. (Public Senior Advisor)

data privacy debates, which are particularly relevant for the public sector. Our findings show that an updated TOE model is needed, particularly when discussing the environmental variable. This claim is based on the need to showcase the nuances of environmental variables such as sustainability factors, social factors, and policy factors applicable to BT research and other kinds of emerging technologies.

Dimensions of TOE framework

Technology factor

Awareness challenges remain significant for BT. Toufaily et al. (2021) described BT as immature; however, our findings run against this characterization, as our results indicate that BT perception is subjective on the basis of the interviewees' knowledge. Misconceptions persist due to poor marketing of BT and limited understanding because many individuals associate BT with Bitcoin, which results in the perception that BT uses a large amount of energy. Blockchain's back-end nature limits visibility compared with trend-driven front-end technologies such as AI or IoT, contributing to misconceptions. Many interviewees highlighted the absence of industry-tangible examples, a sentiment echoed by Tan et al. (2022b), who emphasized the importance of pilot studies to address skepticism.

Security and privacy concerns are another significant characteristic of BT in terms of technology. In our data, privacy was touched upon briefly, where respondents indicated that stakeholders are concerned about transparency due to the fear that BT may reveal trade secrets. This concern supports the work of Batubara et al. (2018), who identify transparency trade-offs as key challenges to blockchain adoption in e-government systems. Lustenberger et al. (2021) add more context and indicate that readiness, at least in terms of clear regulations and alignment of interests among stakeholders, significantly shapes perceptions about blockchain security. Our findings add to the above idea by showing how perceived transparency risks interact with organizational priorities to create skepticism.

More precisely, whereas Lustenberger et al. (2021) argue that external factors, such as ecosystem readiness, are the main drivers of blockchain adoption, our data indicate that internal organizational factors, such as concerns about competitive disadvantage and data control, are at least as influential in shaping attitudes toward blockchain security. Our findings also complement this idea by showing how internal readiness, in terms of training and direct involvement in pilot projects, can make a difference in overcoming skepticism. Building in training and pilot projects can fill the gap that occurs from the theoretical levels to practice, allowing broader diffusions of the technology. The only critical point is the energy consumption issue. Gulen and Karaagac (2024) associated BT with inefficiency since it is considered an environmental concern, especially in agriculture. Our findings contradict these findings by highlighting misconceptions that associate BT with just cryptocurrency and therefore require awareness creation to change this image of BT as a sustainable solution.

Building on the work of Carson et al. (2018) and Toufaily et al. (2021), who emphasize cost as a barrier, our findings add nuance by showing how this perception varies across sectors. The public sector perceives cost as an important concern but not a major issue because of its resources, with a focus on service quality, scalability, citizens' trust, and lack of flexibility (Tan et al., 2025). In private organizations, the

cost is more of an unplanned expense rather than a barrier. Some interviewees believed that BT could fall in line with financial plans if costs were forecasted and aligned with company needs. This distinction fills out the picture, showing cost barriers dependent on the sector and bound up with organizational budgeting practices. Khalfan et al. (2022) identified cost overruns and challenges with legacy systems, especially in public e-procurement, which is in line with our findings on integration costs. Private organizations seem to be more agile, focusing on real-time tracking, whereas public entities focus on stability. Other challenges that also arise are related to scalability and compatibility. Sousa (2023) mentioned the scalability limitations of public blockchains such as Ethereum. Our findings go beyond this by highlighting the relevance of gradual adoption through pilot testing to be compatible with legacy systems. Similarly, regulatory and standardization gaps, as noted by Cagigas et al. (2023), increase in specific industries, such as the nuclear energy industry, where aging infrastructure requires incremental integration, as complimented by our findings.

Organizational factors

According to Junchairussamee and Kraiwanit (2024), organizational inertia in BT adoption appears because of a lack of clarity and consensus about its potential and applications. Our findings further highlight emotional factors, such as fear of change, job loss, or organizational instability. This is an important factor that strengthens resistance in the adoption process and may delay partnerships internally and externally. Workers may view BT as a threat, thinking that it will unsettle their comfortable workflows or make their skill sets irrelevant. In this situation, it is the leadership's role in clearing these fears. For example, one interviewee illustrated the need to establish a feeling of safety and that personnel contribute their own ideas and perspectives. According to Koster and Borgman (2020), top management's fluctuating support for BT initiatives has emphasized different approaches in terms of adoption strategies. However, bottom-up initiatives sometimes prove successful, especially when universities manage to facilitate experimentation in BT projects. Our findings stress the importance of top management in creating change. For our interviews, leaders and managers emphasized empathy, inclusion, and direct supervision by top management as key factors.

While Koster and Borgman (2020) are aware of the apparent success of bottom-up approaches, they also refer to the presence of top-down strategies, including those recently initiated by global organizations such as the World Economic Forum. Our findings distinguish between sectors and indicate that in the private sector, the main approach is middle-top-bottom, with middle management acting as an intermediary between leadership teams and working teams. In contrast, the public sector relies more on top-down approaches, depending on the senior management layer, to lead and drive BT initiatives (Haq et al., 2024). Zhang et al. (2024) identify top management support as one of the deciding enablers for BT initiatives. On the other hand, our findings refute this simplification and highlight the role of middle management in cross-departmental alignment and the reduction of resistance within the context of decentralized private organizations.

Junchairussamee and Kraiwanit (2024) further identify the role of trust in developing interorganizational relationships. Our findings indicate that one of the major reasons for the failure of partnerships, especially within the public sector, comes from a lack of trust. What holds stakeholders back from full-fledged collaboration is the fact that they are dependent on others. This lack of trust opens a critical avenue for future research. Even after years of blockchain development, organizations struggle to trust one another enough to innovate together. Organizational silos further create barriers to internal collaboration across departments. According to Xanthopoulou (2022), governance plays a critical role in breaking down these barriers in the public sector. Tafuro et al. (2023) highlight the importance of breaking silos to ensure seamless adoption in public–private partnerships. Our findings extend these arguments by showcasing how private organizations leverage intraorganizational collaboration more flexibly, allowing individual departments to experiment with blockchain solutions independently. In contrast, public organizations often face bureaucratic barriers that slow cross-departmental integration. According to Dehghani et al. (2022), a lack of technological knowledge in organizations is the major barrier, thus making organizational readiness and internal resources crucial. Our findings further identify the critical elements that add to this by including leadership and cultural dynamics as important determinants of adoption.

Environmental factors

Dehghani et al. (2022) found regulatory uncertainty and standardization issues to be among the main barriers. They show how these factors make adoption hesitant due to unclear requirements for compliance and fragmentation of standards. While agreeing with the impact of regulatory uncertainty, our findings emphasize the need for ecosystem-level collaboration to address such barriers. It starts with the idea of earned trust in public–private networking as an enabler for overcoming regulatory and standardization challenges through actionable insight for policymakers and stakeholders.

The literature demonstrates great consistency in the emphasis on regulatory frameworks as one of the key environmental factors affecting blockchain adoption. According to Chittipaka et al. (2023), supportive regulatory frameworks are highly necessary for encouraging adoption in emerging markets. Public–private partnerships may thus play a pivotal role in shaping favorable policies and fostering an enabling ecosystem that supports BT initiatives. Zhang et al. (2024) and Llano et al. (2024) highlight government preparedness and standardized policies that are identified to facilitate the integration of BT, especially within public sector contexts. Our results, therefore, echo these findings but add further depth to identifying the gap in regulatory flexibility between the public and private sectors. While in the public sector, strict adherence to existing frameworks delays the adoption of blockchains, in private organizations, ambiguity in regulations is leveraged to innovate and secure competitive advantages, especially for BT, which does not yet have fixed regulations. Junchairussamee and Kraiwanit (2024) also stress that trust and interorganizational relationship issues play crucial roles in blockchain adoption. However, our research emphasizes another equally important constituent of an adoption ecosystem, collaboration between the public and private sectors, particularly in handling issues of scalability and compatibility.

Cagigas et al. (2023) and Tafuro et al. (2023) debate the means whereby sharing knowledge and building trust are basic elements of this type of partnership. Our findings add to this argument by highlighting a set of actionable mechanisms, including research initiatives and interagency academic networks, that are usually absent in discussions of practical strategies of implementation. Following Sousa (2023), sustainability and environmental issues are also important factors since BT is recognized as an energy-consuming technology. What is framed in the literature as a general problem comes from our results, at least as sector-related. Private organizations focus on finding a balance between energy efficiency and operational gains, whereas public sector entities frame energy consumption concerns within a broader sustainability and public accountability scope, taking into consideration the scale of operations.

Overall, our findings support those of Toufaily et al. (2021), who assert that BT adoption by the public sector is driven by institutional intentions to comply and be transparent and that the findings are similar, especially when those of the private sector correlate with efficiencies and competitive advantages. However, we extend beyond the related findings and find that regulatory challenges are not just legal inconveniences for the public sector but, instead, adoption determinants in a more strategic fashion. Our findings disagree with those of Dehghani et al. (2022) to an extent, as they asserted that overall, organizational readiness is the most critical criterion for adoption across sectors. While we agree that organizational readiness is crucial for the private sector,

we find that the public sector is more driven by environmental factors such as legislation and stakeholders who have national or EU goals and regulations. Our findings support and extend those of Mahula et al. (2025), who assessed the difference between managerial-driven categories for adopting BT across sectors. We extend their findings to deduce that managerial-driven categories for the public sector stem from institutional pressures rather than blockchain's perceived benefits.

Policy and strategic implications

On the basis of our findings, we compacted a series of additional suggestions for blockchain applications within the industry. National governments should create a national blockchain strategy with regulatory sandboxes. These institutional agencies can play an exploratory role in such blockchain solutions before full implementation. In addition, interoperability standards among agencies should be established. This ensures that organizations need blockchain educational training and workshops to ensure advancements in technological prowess. In addition, companies should gradually implement such changes. Start with low-risk blockchain applications (i.e., supply chain tracking) before moving on to financial or identity applications. Sponsoring government-driven initiatives and grants for an empowerment hub of innovation would create a public–private partnership for research. The public sector comes to play with private sector resources, and the private sector has its systems modified for the expected future SEC requirements.

Within the public sector, for example, government agents can promote adoption by creating regulatory sandboxes that promote initial blockchain testing to occur on a smaller scale with no need for immediate regulatory compliance. This minimizes the need for initial investment; therefore, many use cases can be explored without fear of failure but also without the anticipated need to pay to fail. Projects on a smaller scale are not subjected to legal and regulatory scrutiny; therefore, these arenas promote creative development. In addition, the collaborative establishment of interoperability standards helps BT integrate more easily with any legacy digital services that the government may have in place to ensure optimal operation and data security. Finally, blockchain training programs create a greater sense of readiness for adoption within public sector organizations. This facilitates a greater likelihood that staff will buy in and comply with the road.

For public and/or private sector organizations that are government-subsidized through funding and resources, the answer to successfully implementing BT is to ensure that they engage citizen awareness of the initiative. This entails much, but primarily, sponsorship of government support for ethical and legal compliance regulations. Without regulations, many private companies may find themselves in legal hot water, but if the public sector department aligns with government agencies and regulatory agencies to determine appropriate compliance, then initiatives can be better aligned with future blockchain-compliant organizational needs. Furthermore, transparency is key, and by sponsoring citizen awareness of goals, shortcomings, and progress, public sector organizations will operate with better citizen sentiment while simultaneously sponsoring a growing technological business endeavor. Therefore, efforts that champion the decentralization of public data storage should not raise a red flag for public/private sector blockchain implementations because such efforts could save taxpayer dollars and promote transparency.

Ultimately, opportunities for implementation exist for regulators and practitioners. The major takeaway is that by assessing the regulatory proposed implementation options with a desire for technology adoption, they can provide implementation plans for collaboration projected across the entities to provide incentives and the opportunity for regulators to adopt the technology yet acknowledge compliance-based regulations. In addition, incubators would allow regulatory persons an opportunity to work alongside business leaders within a more commercialized space to brainstorm and pilot-test digital identity, government revenue generation, and other government record endeavors existing within the blockchain.

Theoretical implications

This study adds to the theoretical, empirical, and practical considerations of integrating BT into the public and private sectors. The implications for theory also extend the TOE framework, and it was discovered in this investigation that the variables that govern blockchain adoption are sector specific. However, previous studies seemingly found that governance factors, such as contextual dependence, are universal to adoption. For example, the findings suggest that governance factors are emphasized within the public sector. This is because of the need for regulations, compliance, and institutional legitimacy for adoption. However, for the private sector, this is not the case. This simply means that the private sector needs to be ready for adoption at the organizational level, meaning that it needs to determine whether BT can be valuable and profitable from an operational efficiency standpoint.

Empirically, this research adds to the body of knowledge by offering a comparative evaluation of blockchain adoption across the public and private sectors. Existing research explores the adoption and utilization of this emerging technology across both sectors in an independent manner, meaning that the intra-sector findings of fields are fragmented in the literature. Therefore, by acknowledging public and private sector endeavors, distinctions in obstacles, advantages, and driving forces are established for both realms.

Theoretical and empirical insights are established in this study, but adjustments are ultimately made. Adjustments can be made according to future application opportunities. Regulators, business owners, and public decision-makers can all learn from the actions projected going forward by the sector, as these findings emerge from in-field assessments. For the government, future regulatory compliance and interoperability standards; for the business sector, a gradual implementation approach with short-term gains; and for the hybrid private/public sector, grant opportunities and collaborations for publicly funded research. These adjustments not only serve the needs of each investigated field's current situation but also reduce and reaccelerate adjustment of what can be a potentially transformative technology.

Conclusions

This research investigates public versus private sector intentions and barriers to blockchain adoption via the technology-organization-environment framework. The findings indicate that the sectors differ in terms of anticipated solutions and barriers. Technologically, both sectors realize that BT could enhance security and transparency; however, their concerns are different. The private sector is concerned with the scalability and efficiency of costs for payment to facilitate the most cost-effective performance and profit potential. The public sector, however, is concerned with integration with legacy systems, which, although older and more obsolete, are still used, rendering more citizens cautious regarding adoption.

Moreover, organizational determinants differ among industries in how each industry chooses to implement BT. In the private sector, adoption is an optional choice of profit; 'does it help the company?' Therefore, if the company can spare the time and resources to implement and subsequently adopt this new technology, it will do so. In the public sector, adoption is a governmental necessity. The public sector is a more vertical, hierarchical scene. Therefore, it is not adopted on the basis of what citizens want, and in turn, it does not mean that public citizens will adopt the service; instead, it is adopted by governmental necessity. There is a more bureaucratic response with less flexibility but more structured regulatory initiatives. Organizationally, leadership styles and decision-making processes reflect the contrasting cultures of public accountability versus private sector agility.

Environmental constraints, especially concerning regulation, present

significant barriers to blockchain implementation in both sectors. However, they are more formally established within the public sector. Ideally, with more legal regulation and government oversight, the utilization is performed in the proper context; however, it is established as too much red tape that halts the proper and effective utilization of emerging technological advancements. The private sector, however, although under the eyes of some regulatory agencies, has more freedom. For example, companies can tinker with various components on a smaller scale with incremental implementation options before implementing them on a larger scale.

However, regardless of these differences, the findings support a forthcoming public–private partnership. Where there are concerns with regulation and interoperability, a public–private sector partnership would be ideal. Where we feel that standards can be set, it would be best to have those in the public and private sectors who are engaged with blockchain endeavors. Furthermore, anything regulated by policy will need the participation of the public sector from the beginning. Therefore, the partnership accommodates all civic and governmental needs.

This study contributes to the blockchain adoption body of knowledge in three ways—contributing to theory, practice, and empirics. With respect to the theoretical contribution, this study extends the TOE framework by incorporating industry-specific dynamics as a mediating mechanism through which entrepreneurs recognize blockchain adoption benefits more quickly and efficiently. For example, institutional legitimacy as it pertains to governmental authorities presents a substantial driver of adoption since alignment with regulatory demands and political goals is essential when choosing to use any emerging technology.

Empirically, this study is one of the few actions to evaluate public versus private blockchain adoption, as they are relative. When studies assess either one side or the other, taken out of context, they fail to make sense of fragmentary observations of something that is not based on the other. Thus, this assessment seeks to parse out certain relative advantages and relative disadvantages of implementation on the basis of institutional settings. Ultimately, the study is practically relevant for governmental and private sector practitioners. The results facilitate the policy-making process, training improvements, and regulatory changes that encourage more effective implementation of blockchain. The results of this study provide important lessons that can be learned from BT adoption in both the public and private sectors while highlighting several areas that require further investigation.

Limitations and future research agenda

Despite this contribution enriching the ongoing dialog about blockchain adoption, it is not without limitations, as mentioned before. First, the regulatory context is only that of Finland. Finland has a unique regulatory system and technological landscape, which may not be directly relevant to other national contexts because of technological advances, economic situations, policies, restrictions, available infrastructure, and social understanding of the phenomenon. In this sense, future research can examine blockchain adoption across multiple countries to strengthen the comparative rationale. Future research can appropriately generalize findings and determine the similarities and differences in blockchain adoption relative to other countries' regulatory and market systems.

Second, the methodology section of this study offers a detailed view of the process of composing the results of this article; however, certain limitations must be acknowledged. Importantly, self-reported data from the interviewee's responses may be biased, as individuals may tend to present blockchain adoption efforts in a more positive or negative light depending on their experiences. This may not represent the full real picture of BT. Efforts have been made to ameliorate this effect by probing questions and cross-referencing responses. A quantitative survey, in addition to such a qualitatively rich interview process, would provide more statistically valid results to support or refute the findings of this study.

Third, there is a timeline for the research that implies an issue, as BT is something that is gradually being implemented. Policies, regulations, and abilities all change; at different points in time, one's desire to implement something may change. A longitudinal study would more accurately evaluate the viability of BT for extended use by the public and private sectors. However, future studies should also explore the relationship between blockchain implementation and other developing technologies, such as AI or the IoT. For example, a stronger evaluation of where BT may currently stand in the future could involve governance and business with cross-industry collaborations and metaverse-type settings.

Among the most important challenges is the persistence of trust deficits, especially within the public sector, where collaborative initiatives often fail due to a lack of sufficient commitment or interest. Future research should focus on whether the deficit of trust is due to emotional factors such as fear of change or a technical misconception about BT applications and risks. Understanding these dynamics is important in developing better partnerships and successful blockchain initiatives.

Another promising area of investigation concerns the role of universities as blockchain enablers. The interviewees in this research mentioned universities as potential intermediaries bridging the public–private divide by creating partnerships, piloting blockchain hubs, and fostering trust across sectors. Research could be based on how academia can play roles beyond traditional research functions in mitigating barriers such as readiness at an ecosystem level and intersectoral collaboration. Moreover, the role of universities as potential innovation hubs may provide a chance for experimentation and applied research on BT, which would be critical in overcoming resistance and building momentum for adoption. Another persistent challenge in blockchain adoption that deserves further research is scalability. Scalability issues tend to manifest differently in public and private settings. In the public context, scalability issues often appear to be related to resource-intensive issues, such as the need for changes in legacy systems and considerations of national-level implementation readiness. However, in the private sector, the notion tends to be linked with operational issues and market agility. Thus, future research should address these barriers in terms of sector-specific solutions that provide a balance between technical, organizational, and regulatory considerations.

CRediT authorship contribution statement

Melisa Petra Benchis: Writing – review & editing, Writing – original draft, Visualization, Validation, Methodology, Formal analysis, Data curation, Conceptualization. **Khuram Shahzad:** Writing – review & editing, Validation, Supervision, Resources, Project administration, Methodology, Funding acquisition, Data curation, Conceptualization. **Sorin Dan:** Writing – review & editing, Supervision, Methodology, Conceptualization.

Funding acknowledgement

This work was supported by the Foundation for Economic Education (Liikesivistysrahasto) [BizPub project, grant numbers 200264 and 210257].

References

Abbas, Z., & Myeong, S. (2024). A comprehensive study of blockchain technology and its role in promoting sustainability and circularity across large-scale industry. *Sustainability, 16*, 4232.

Akram, S. V., Malik, P. K., Singh, R., Anita, G., & Tanwar, S. (2020). Adoption of blockchain technology in various realms: Opportunities and challenges. *Security and Privacy, 3*(5), e109.

Alhasan, H., & Hamdan, A. (2023). Blockchain technology and environmental sustainability. In R. El Khoury, & N. Nasrallah (Eds.), *Emerging trends and innovation in business and finance* (pp. 735–745). Springer Nature Singapore.

Andoni, M., Robu, V., Flynn, D., Abram, S., Geach, D., Jenkins, D., … Peacock, A. (2019). Blockchain technology in the energy sector: A systematic review of challenges and opportunities. *Renewable and Sustainable Energy Reviews, 100*, 143–174.
Andrews, R., Boyne, G., & Walker, R. (2011). Dimensions of publicness and organizational performance: A review of the evidence. *Journal of Public Administration Research and Theory, 21*, 301–319.
Asa, K. J., & Zosu, S. J. (2023). Enhancing procurement and supply chain management for sustainable development through digital transformation. *International Journal of African Research Sustainability Studies, 2*(2), 62–76.
Awa, H. O., Ojiabo, O., & Orokor, L. (2017). Integrated technology-organization-environment (T-O-E) taxonomies for technology adoption. *Journal of Enterprise Information Management, 30*(6), 893–921.
Awa, H. O., Ukoha, O., & Emecheta, B. C. (2016). Using TOE theoretical framework to study the adoption of ERP solution. *Cogent Business & Management, 3*(1), 1196571.
Baker, J. (2011). The Technology–Organization–Environment framework. *Information Systems Theory: Explaining and Predicting Our Digital Society, 1*, 231–245.
Batubara, F. R., Ubacht, J., & Janssen, M. (2018). Challenges of blockchain technology adoption for e-government: A systematic literature review. In *Proceedings of the 19th Annual International Conference on Digital Government Research: Governance in the Data Age* (pp. 1–9).
Boyne, G. A. (2002). Public and private management: What's the difference? *Journal of Management Studies, 39*, 97–122.
Cagigas, D., Clifton, J., Díaz-Fuentes, D., Fernández-Gutiérrez, M., & Harpes, C. (2023). Blockchain in government: Toward an evaluation framework. *Policy Design and Practice, 6*, 397–414.
Cappai, M. (2023). The role of private and public regulation in the case study of crypto-assets: The Italian move towards participatory regulation. *Computer Law & Security Review, 49*, Article 105831.
Carson, B., Romanelli, G., Walsh, P., & Zhumaev, A. (2018). Blockchain beyond the hype: What is the strategic business value. *McKinsey & Company, 1*, 1–13.
Charlebois, S., Latif, N., Ilahi, I., Sarker, B., Music, J., & Vezeau, J. (2024). Digital traceability in agri-food supply chains: A comparative analysis of OECD member countries. *Foods (Basel, Switzerland), 13*, 1075.
Chittipaka, V., Kumar, S., Sivarajah, U., Bowden, J. L.-H., & Baral, M. M. (2023). Blockchain technology for supply chains operating in emerging markets: An empirical examination of technology-organization-environment (TOE) framework. *Annals of Operations Research, 327*, 465–492.
Chu, H., Zhang, P., Dong, H., Xiao, Y., Ji, S., & Li, W. (2023). A survey on smart contract vulnerabilities: Data sources, detection and repair. *Information and Software Technology, 159*, Article 107221.
Clemente-Almendros, J. A., Nicoara-Popescu, D., & Pastor-Sanz, I. (2024). Digital transformation in SMEs: Understanding its determinants and size heterogeneity. *Technology in Society, 77*, Article 102483.
Cui, M., Feng, T., & Wang, H. (2023). How can blockchain be integrated into renewable energy? –A bibliometric-based analysis. *Energy Strategy Reviews, 50*, Article 101207.
Daidai, F., & Tamnine, L. (2023). Blockchain technology in finance: A literature review. In S. Motahhir, & B. Bossoufi (Eds.), *Digital technologies and applications* (pp. 218–229). Springer Nature Switzerland.
Dehghani, M., William Kennedy, R., Mashatan, A., Rese, A., & Karavidas, D. (2022). High interest, low adoption. A mixed-method investigation into the factors influencing organisational adoption of blockchain technology. *Journal of Business Research, 149*, 393–411.
Denzin, N. K. (2012). Triangulation 2.0. *Journal of Mixed Methods Research, 6*, 80–88.
European Union. (2024). *EU blockchain ecosystem developments 3"*. EU Blockchain Observatory and Forum - European Commission. published by theRetrieved from https://blockchain-observatory.ec.europa.eu/news/eu-blockchain-ecosystem-developments-3-published-eu-blockchain-observatory-and-forum-2024-05-21_en.
Fusch, P. I., & Ness, L. R. (2015). Are we there yet? Data saturation in qualitative research. *The Qualitative Report, 20*(9), 1408–1416.
Ganguly, K. K. (2024). Understanding the challenges of the adoption of blockchain technology in the logistics sector: The TOE framework. *Technology Analysis & Strategic Management, 36*, 457–471.
Gioia, D., Corley, K., & Hamilton, A. (2013). Seeking qualitative rigor in inductive research. *Organizational Research Methods, 16*, 15–31.
Gökalp, E., Gökalp, M., & Gökalp, S. (2020). Blockchain-based Supply Chain management: Understanding the determinants of adoption in the context of organizations. *Information Systems Management, 39*, 1–22.
Gulen, K., & Karaagac, A. (2024). Agricultural food supply chain with blockchain technology: A review on Turkey. *Journal of Global Strategic Management, 16*(2), 013–028.
Gupta, A., Singh, R. K., & Kamal, M. M. (2024). Blockchain technology adoption for secured and carbon neutral logistics operations: Barrier intensity index framework. *Annals of Operations Research*, 1–34.
Hafeez, S., Shahzad, K., & De Silva, M. (2025). Enhancing digital transformation in SMEs: The dynamic capabilities of innovation intermediaries within ecosystems. *Long Range Planning, 58*(3), Article 102525.
Haq, S. H. U., Dan, S., & Shahzad, K. (2024). Leadership competencies and blockchain implementation in public sector organizations: A sensemaking approach. *International Journal of Public Sector Management*.
Haroun, M. H., Gohar, N., & Hanna, H. A. (2020). TOE model: Adoption of blockchain. *The Business & Management Review, 11*, 179–185.
Hossain Faruk, M. J., Alam, F., Islam, M., & Rahman, A. (2024). Transforming online voting: A novel system utilizing blockchain and biometric verification for enhanced security, privacy, and transparency. *Cluster Computing, 27*(4), 4015–4034.
Irani, Z., Abril, R. M., Weerakkody, V., Omar, A., & Sivarajah, U. (2023). The impact of legacy systems on digital transformation in European public administration: Lesson learned from a multi case analysis. *Government Information Quarterly, 40*, Article 101784.
Junchairussamee, S., & Kraiwanit, T. (2024). Bridging the technology-government policy divide: Understanding the acceptance of blockchain adoption in Thailand's agriculture. *AU-GSB e-Journal, 17*, 73–84.
Juszczyk, O., & Shahzad, K. (2022). Blockchain technology for renewable energy: Principles, applications and prospects. *Energies, 15*(13), 4603.
Kassen, M. (2024). Blockchain and public service delivery: A lifetime cross-referenced model for e-government. *Enterprise Information Systems, 18*, Article 2317175.
Kayani, U., & Hasan, F. (2024). Unveiling cryptocurrency impact on financial markets and traditional banking systems: Lessons for sustainable blockchain and interdisciplinary collaborations. *Journal of Risk and Financial Management, 17*, 58.
Khalfan, M., Azizi, N., Haass, O., Maqsood, T., & Ahmed, I. (2022). Blockchain technology: Potential applications for public sector e-procurement and project management. *Sustainability, 14*, 5791.
Koster, F., & Borgman, H. S. (2020). New kid on the block! understanding blockchain adoption in the public sector. In *Proceedings of the 53rd Hawaii International Conference on System Sciences (HICSS)*.
Kusi, S. Y., Shahzad, K., & Dan, S. (2024). Blockchain technology, leadership competencies, and organizational change: A conceptual exploration and future research agenda. *Trust and artificial intelligence (pp. 10–25)*. Routledge.
Li, L., Wu, J., & Cui, W. (2023). A review of blockchain cross-chain technology. *IET Blockchain, 3*, 149–158.
Llano, E. A., Hurmelinna-Laukkanen, P., & Haapanen, L. (2024). Blockchain for the circular economy: Implications for public governance. *International Journal of Public Sector Management*.
Lustenberger, M., Malešević, S., & Spychiger, F. (2021). Ecosystem readiness: Blockchain adoption is driven externally. *Frontiers in Blockchain, 4*.
Mahula, S., Tan, E., Crompvoets, J., & Timmers, P. (2025). What motivates public sector organisations to use blockchain? *International Journal of Public Sector Management, 38*(1), 118–138.
Malik, S., Chadhar, M., Chetty, M., & Vatanasakdakul, S. (2022). Adoption of blockchain technology: Exploring the factors affecting organizational decision. *Human Behavior and Emerging Technologies*, 1–14.
Manzoor, R., Sahay, B. S., & Singh, S. K. (2022). Blockchain technology in supply chain management: An organizational theoretic overview and research agenda. *Annals of Operations Research*, 1–48.
MAXQDA. (2024). MAXQDA for Windows and Mac [Computer software]. https://www.maxqda.com/download-now.
Mustafa, G., Rafiq, W., Jhamat, N., Arshad, Z., & Rana, F. A. (2024). Blockchain-based governance models in e-government: A comprehensive framework for legal, technical, ethical and security considerations. *International Journal of Law and Management, 67*, 37–55.
Nakamoto, S. (2008). *Bitcoin: A Peer-to-Peer Electronic Cash System*. Available https://bitcoin.org/bitcoin.pdf.
Osborne, S. P. (2006). The new public governance? *Public Management Review, 8*(3), 377–387.
Rahman, M. H., Yeoh, W., & Pal, S. (2024). Exploring factors influencing blockchain adoption's effectiveness in organizations for generating business value: A systematic literature review and thematic analysis. *Enterprise Information Systems, 18*, Article 2379830.
Rejeb, A., Rejeb, K., Zrelli, I., Süle, E., & Iranmanesh, M. (2024). Blockchain technology in the renewable energy sector: A co-word analysis of academic discourse. *Heliyon, 10*, Article e29600.
Ressi, D., Romanello, R., Piazza, C., & Rossi, S. (2024). AI-enhanced blockchain technology: A review of advancements and opportunities. *Journal of Network and Computer Applications*, 225.
Rodríguez Bolívar, M. P., Scholl, H. J., Bolívar, R., & Scholl, H. J (2019). Mapping potential impact areas of blockchain use in the public sector. *Information Polity, 24*, 359–378.
Roulston, K., & Choi, M. (2018). *The Sage handbook of qualitative data collection*. SAGE Publications Ltd.
Sanda, O., Pavlidis, M., & Polatidis, N. (2022). A regulatory readiness assessment framework for blockchain adoption in healthcare. *Digital, 2*, 65–87.
Saunders, B., Sim, J., Kingstone, T., Baker, S., Waterfield, J., Bartlam, B., Burroughs, H., & Jinks, C. (2018). Saturation in qualitative research: Exploring its conceptualization and operationalization. *Quality & Quantity, 52*, 1893–1907.
Shahzad, K. (2020). Blockchain and organizational characteristics: Towards business model innovation. In *Advances in Creativity, Innovation, Entrepreneurship and Communication of Design: Proceedings of the AHFE 2020 Virtual Conferences* (pp. 80–86). Springer International Publishing.
Shahzad, K., Dan, S., Imran, F., Holtkamp, P., Niemi, M. K., & Meyer, M. (2024b). Limits of open innovation during the organizational change: A case study of a partner campus. *R&D Management, 54*(5), 1063–1086.
Shahzad, K., Hafeez, S., Heimo, T., Mäenpää, A., Mubarak, M. F., & Evans, R. (2025a). Developing the innovation capabilities of SMEs: The role of intermediary firms in knowledge ecosystems. *IEEE Transactions on Engineering Management, 72*, 604–618.
Shahzad, K., Helo, P., Ranta, M., & Nousiainen, E. (2024a). Blockchain technology for operational excellence and supply chain resilience: A framework based on use cases and an architecture demonstration. *Technology Analysis & Strategic Management*, 1–18.
Shahzad, K., Imran, F., & Butt, A. (2025b). Digital transformation and changes in organizational structure: Empirical evidence from industrial organizations. *Research-Technology Management, 68*(3), 25–40.
Sharma, P., Jindal, R., & Borah, M. D. (2022). A review of blockchain-based applications and challenges. *Wireless Personal Communications, 123*, 1201–1243.

Sorsa, K., & Salmi-Tolonen, T. (2021). Deregulation and proactive law as regulative innovations: A case study from Finland. In A. Masson, & G. Robinson (Eds.), *Mapping legal innovation: Trends and perspectives* (pp. 357–381). Springer International Publishing.

Sousa, M. J. (2023). Blockchain as a driver for transformations in the public sector. *Policy Design and Practice, 6*, 415–432.

Spanos, A., & Kantzavelou, I. (2023). A blockchain-based electronic voting system: EtherVote.

Sung, C. S., & Park, J. Y. (2021). Understanding of blockchain-based identity management system adoption in the public sector. *Journal of Enterprise Information Management, 34*, 1481–1505.

Suwanposri, C., Bhatiasevi, V., & Thanakijsombat, T. (2021). Drivers of blockchain adoption in financial and supply chain enterprises. *Global Business Review*.

Tafuro, A., Dammacco, G., & Costa, A. (2023). A conceptual study on the role of blockchain in sustainable development of public–private partnership. *Administrative Sciences, 13*, 175.

Taherdoost, H. (2022). A critical review of blockchain acceptance models—Blockchain technology adoption frameworks and applications. *Computers, 11*, 24.

Tan, E., Dan, S., & Shahzad, K. (2025). Bridging the chasm between "what could be" and "what is": The impact of blockchain technologies on public service management. *International Journal of Public Sector Management, 38*(1), 1–11.

Tan, E., Kleizen, B., Simonofski, A., Willem, P., & Sabbe, M. (2022b). Digital (R) evolution in Belgian Federal Government: An open governance ecosystem for big data, artificial intelligence, and blockchain (DIGI4FED). *Database systems for advanced applications (DASFAA 2020), pt i (Vol. 12112)*. Springer.

Tan, E., Mahula, S., & Crompvoets, J. (2022a). Blockchain governance in the public sector: A conceptual framework for public management. *Government Information Quarterly, 39*, Article 101625.

Tornatzky, L. G., Fleischer, M., & Chakrabarti, A. K. (1990). *The processes of technological innovation*. Lexington Books.

Toufaily, E., Zalan, T., & Dhaou, S. B. (2021). A framework of blockchain technology adoption: An investigation of challenges and expected value. *Information & Management, 58*, Article 103444.

Tripathi, G., Ahad, M. A., & Casalino, G. (2023). A comprehensive review of blockchain technology: Underlying principles and historical background with future challenges. *Decision Analytics Journal, 9*, Article 100344.

Upadhyay, N. (2020). Demystifying blockchain: A critical analysis of challenges, applications and opportunities. *International Journal of Information Management, 54*, Article 102120.

Wang, Y., Singgih, M., Wang, J., & Rit, M. (2019). Making sense of blockchain technology: How will it transform supply chains? *International Journal of Production Economics, 211*, 221–236.

Wolfond, G. (2017). A blockchain ecosystem for digital identity: Improving service delivery in Canada's public and private sectors. *Technology Innovation Management Review, 7*, 35–40.

Wong, L. W., Tan, G. W. H., Lee, V. H., Ooi, K. B., & Sohal, A. (2020). Unearthing the determinants of blockchain adoption in supply chain management. *International Journal of Production Research, 58*, 2100–2123.

Xanthopoulou, P. (2022). Blockchain and the digital transformation of the public sector: The Greek experience. *Technium Social Sciences Journal, 32*, 558–570.

Xanthopoulou, P., Antoniadis, I., & Saprikis, V. (2023). Blockchain adoption in public sector: A value-driven approach. In *Communications of International Proceedings*.

Yan, Z., Zhao, X., Liu, Y.(Alison), & Luo, X.(Robert) (2024). Blockchain-driven decentralized identity management: An interdisciplinary review and research agenda. *Information & Management, 61*, Article 104026.

Zhang, Y., Tavalaei, M. M., Parry, G., & Zhou, P. (2024). Evolution or involution? A systematic literature review of organisations' blockchain adoption factors. *Technological Forecasting and Social Change, 208*, Article 123710.