Operational Research in Engineering Sciences: Theory and Applications
Vol. 8, Issue 1, 2025, pp. 143-170
ISSN: 2620-1607
eISSN: 2620-1747
DOI: https://doi.org/10.5281/zenodo.15814911

BLOCKCHAIN ADOPTION IN PROJECT MANAGEMENT: EXPLORING ORGANIZATIONAL AND LEGAL CHALLENGES THROUGH SLR AND TOPSIS

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Received: 29 November 2024
Accepted: 10 March 2025
First Online: 30 March 2025

Research Paper

Abstract: *Blockchain technology is widely recognized as a form of distributed ledger technology, which holds substantial promise for driving economic and social transformation. However, despite growing global interest its adoption within organizational project management practices remains limited. This study seeks to investigate the underlying factors contributing to this slow uptake by employing a mixed-method approach. The research integrates a systematic literature review (SLR) of 19 peer-reviewed articles published between 2019 and 2024 to identify key challenges with a particular focus on organizational change management and legal compliance, through thematic synthesis the study uncovers critical technological and institutional barriers that hinder adoption. To prioritize and evaluate the most influential challenges the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) was applied using the web-based tool OnlineOutput enabling an efficient and structured multi-criteria decision-making framework. Results underscore the importance of leadership and strategic support deficiencies in shaping blockchain integration outcomes. The study contributes both a theoretical and practical lens for understanding blockchain adoption in project management and identifies key research gaps to inform future investigation.*

Keywords: *Project Management, Blockchain Technology, Legal and Regulatory Framework, Organizational Change Management, SLR, TOPSIS.*

1. Introduction

As a foundational emergent technology of the fourth industrial revolution blockchain technology is heralded as the next disruptive revolution to transform the size and shape of organizations including ways through which business transactions are done (Lawlor et al., 2025). However, just like the other current technology

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innovations the first adopters of blockchain technology have experienced different issues and challenges which lead to debates by technical experts on the accounts of the merits and benefits of blockchain alongside rules and regulations and the integration approaches while at its integration phase.

1.1 Problem Addressed

This research focuses on exploring the unexplored intersection between blockchain technology and project management, emphasizing the transformative possibilities that emerge when these two areas are combined. Both blockchain and project management play influential roles in shaping how organizational assets and resources are coordinated and utilized to deliver projects. Blockchain in particular, presents a digital infrastructure capable of improving project workflows by making them more transparent, efficient, and secure (Kim & Kim, 2024; Lawlor et al., 2025). Despite the growing use of blockchain across various sectors, its application within project management—especially in the contexts of regulatory adaptation and managing organizational change—has received little scholarly attention.

A major challenge hindering the adoption of blockchain in project settings is the unstable and constantly shifting nature of regulatory policies across different jurisdictions. This unpredictability complicates compliance efforts and raises concerns related to governance and the protection of sensitive data, which in turn slows down organizational willingness to adopt such technologies for managing projects (Shukla et al., 2024).

Additionally, there is a significant gap in applied knowledge, a lack of documented real-world implementations or lessons learned from organizations that have attempted to integrate blockchain into their operational structures. Deloitte in their latest global blockchain survey (2021) points out a critical disconnect: while a large majority of companies acknowledge the strategic value of blockchain, less than half have actually transitioned from planning to full-scale implementation. This discrepancy highlights the persistent obstacles that organizations encounter particularly when aligning blockchain solutions with internal project management systems. Given these gaps, there is a clear need for a structured and practical framework that guides professionals through the process of adopting blockchain in a project environment (Shukla et al., 2024).

1.2 Research Objective, Aims, and Questions

The aim of this study is to explore and evaluate the organizational and regulatory dimensions affecting the adoption of blockchain technology in project management. Particular emphasis is placed on identifying the challenges associated with organizational change management and legal compliance and on prioritizing these challenges using a structured decision-making approach.

To achieve the above aim the study is guided by the following objectives:

- To evaluate the influence of organizational and regulatory dimensions such as legal compliance and institutional readiness on the adoption of blockchain technology in the organizational project management practices.
- To prioritize the identified adoption challenges using the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) based on expert assessments.

- To develop recommendations for addressing the most critical barriers to blockchain adoption in project management.

This study seeks to answer the following research questions:

- How do organizational and regulatory factors affect the adoption of blockchain technology in project management?
- Which adoption challenges have the greatest impact on blockchain implementation success in project settings?
- What strategies can help decision-makers effectively overcome the regulatory and organizational barriers to blockchain adoption?

2. Review of Literature

2.1 Definition and Characteristics of Blockchain Technology

Blockchain technically refers to a distributed data network or a method to record data through a crypto-analytic hash function, it can also be described as an encoded digital ledger stored on a computer chain in a private or public network (Dong et al., 2023). It constitutes of nodes deployed on a communication network using a common communication protocol, each node within the communication infrastructure stores a copy of the blockchain followed by an implementation of a consensus function to verify the transactions which are immutable and cannot be changed, although the data infrastructure is visible or accessible to the involved parties no one controls the data but they involved in verifying the data without intermediaries (Javaid et al., 2022). In this way, blockchain is viewed as an application layer running over the internet protocols to enable transactions between parties and a registry and inventory systems to record, trace, monitor, and transact tangible, intangible, and digital assets (Kim & Kim, 2024). Literature noted some of the features of blockchain technology that make it unique for industrial applications, as summarized in Table 1.

Table 1: Characteristics of Blockchain Technology

Characteristic	Explanation
Decentralized	System data are accessible, monitored, stored and can be updated over multiple systems.
Transparent	Once validated by the network infrastructure the data is stored immutably and remain transparent and trackable indefinitely.
Immutable	It provides timestamps and controls to assure immutability.
Irreversible	The transactions made at any point are certain and verifiable, with records kept in each chain.
Autonomy	Data records can be securely accessed, modified, stored, and transferred by each blockchain node on its own which eliminate the need for third-party intervention.
Open source	Provides open-source access to individuals within the network with a sense of hierarchy.
Anonymity	When data transactions occur between the nodes, identities of individuals remain anonymous.
Ownership and uniqueness	Each document transmitted via the blockchain retains ownership information encoded through a unique cryptographic hash.
Provenance	A digital record stored on the blockchain accompanies each product that serve as proof of its authenticity and provenance.
Contract automation	It functions as a lightweight computerized program designed to facilitate contract execution.

2.2 Blockchain in Project Management

Owing to the complexities, rigidity, threats to forgery, and funds misappropriation nature of traditional project management practices most project managers now embrace blockchain technology mainly due to its uniqueness of transparency and accountability (Spychiger et al., 2023). Kim and Kim (2024) reckon that blockchain technology has been widely deployed in construction industries with the blockchain-based BIM pack developed to enable communication among project stakeholders to enhance immutable records management, this study identifies various practices through which blockchain technology impacts organizational project management. Purchase management is a crucial aspect of project supply chain management that involves streamlining and management of project activities in a cost-effective manner, as essential aspects of project management communication and traceability have been among the issues faced with traditional project management practices through the use of mail and paper documents (Madanchian & Taherdoost, 2023). However, this has been eliminated by blockchain technology which has enabled purchase management activities into a distributed digitalized network (Lawlor et al., 2025).

In asset and inventory management, projects require proper quality control from initiation to finish to ensure that the project entries can sustain a well-organized supply chain, this can be enhanced by blockchain which only allow authorized access for stakeholders to ascertain their inventory source, manufactures, and mode of transportation (Javaid et al., 2022). Alternatively, blockchain technology can bolster asset management by enabling the transfer of material requirements and project design details as inputs in the chain management system or assigning information to the project managers to effect project design decisions on data sources (Xia et al., 2023). For contract administration, the inherent risks are dire and the need for proper contract planning is unquestionable, blockchain technology through smart contracts can greatly minimize such risk. Smart contract is a computer program automatically executed per the specific parameters within the blockchain, which mainly exhibits the challenge of trust on successful project completion due to internal and external, economic and non-economic complexities (Hossain et al., 2024).

2.3 Block chain Strategy

Studies have recently highlighted the positive impacts of blockchain technology on organizational management across various industries which include manufacturing and logistics (Ramachandran, 2025). The latter has been further enhanced by digitization such as the Internet of Things (IoT) and industry 4.0 trends in organizational practices that lead to the discovery of autonomous supply chain management and smart factories, through these blockchain has valuably enhanced the process visibility and sustainable collaborations via according real-time information and data sharing between the parties (Hossain et al., 2024). (Shukla et al., 2024)observed that despite its positive outlook, adopting blockchain technology is still limited in most industrial applications and this has been mainly due to limited understanding and implementation strategy and resilience in varied business environments.

Recent studies exploring potential benefits and capabilities of blockchain technology in the supply chain management within the organization noted the lack of a formidable strategy, knowledge source and guideline detailing the requirements and feasibility as key barriers to its adoption into the organizational context (Kim & Kim, 2024; Lawlor et al., 2025). This has necessitated examining blockchain integration strategies alongside decision frameworks to familiarize organizational managers with the emergent technology and understand its value and significance in different contexts (Shukla et al., 2024). In the blockchain readiness framework proposed by Balasubramanian et al. (2021),the study unveiled that the government regulations were likely to drive blockchain technology adoption and the legislative and regulative uncertainties hindered its adoption in all firms. This framework underscored the correlation between the parties, facilitating the conditions from the legal and regulatory certainties to the organizational networks, motivational aspects, and change engagement preparedness of the whole organization to drive blockchain technology adoption successfully. However, it is worth noting that examining and understanding how the institutional frameworks (legal and regulatory) impact the adoption of blockchain technology in business management is still nascent.

3. Methodology

This study adopts a comprehensive mixed-method approach that integrates both qualitative and quantitative techniques to ensure a robust analysis of the challenges associated with blockchain adoption. The process begins with a systematic literature review (SLR) of 19 peer-reviewed articles published between 2019 and 2024, aimed at identifying and categorizing the most critical challenges, with a particular emphasis on issues related to organizational change management and legal compliance. Through thematic synthesis of the selected literature, the study uncovers a range of recurring technological and institutional barriers that hinder effective blockchain implementation across organizational contexts. To build on these findings and facilitate a structured evaluation, the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) is subsequently applied. This multi-criteria decision-making method allows for the prioritization and ranking of the identified challenges based on their relative importance and impact. The analysis is conducted using the web-based tool OnlineOutput, which offers an accessible and efficient platform for implementing the TOPSIS methodology, thereby enhancing the decision-making process through systematic comparison and structured assessment of the most influential barriers.

3.1 Systematic Literature Review (SLR)

This research followed the guidelines of Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) reporting statements and the general SLR recommendations by (Tranfield et al., 2003) . A systematic literature review (SLR) was preferred to ensure that all major studies with significant information were included in the thematic analysis to enhance the quality of the study findings, as well as the scientific rigour and reduce bias (Tukamuhabwa et al., 2015).

The criteria of inclusion or exclusion of particular articles was mainly based on the relevance of the article in regards to publication type, publication time, language and aim/focus of the study; as illustrated in the Table 2 below.

The literature search focused on online database search in the following databases: Scopus, IEEE, Emerald Insight, Wiley Online Library, Web of Science, Science Direct (Elsevier) and EBSCOhost, to identify and extract relevant scientific articles for consideration. To this end, the researchers conducted a systematic literature search of all studies in the relevant databases spanning from January 2019 onwards until January 2024. The researchers conducted titles, abstracts, and keyword searches in the listed databases using the following main search terms: “blockchain”, “blockchain technology”, “blockchain regulatory frameworks”, “legal compliance”, “distributed ledger”, “project management.” Furthermore, the identified articles' references and lists of bibliographies were cross-examined to identify more records for possible inclusion.

Table 2: Eligibility Criteria

Criteria	Inclusion	Exclusion
Language	Articles published in the English language	Studies whose full content needs to be written in the English language.
Access	Records available in full-access	Articles that did not allow full access or those whose abstracts were accessible.
Quality	Peer-reviewed research or published empirical studies, including selected conference papers.	Books, non-peer-reviewed records, reports, magazines, etc.
Focus	Discussed either legal and regulatory framework in the context of industrial or institutional application; discussed issues and challenges that hinder blockchain adoption	Studies whose objective did not align to the research objectives; those discussing irrelevant contents

Based on our databases and keyword search the literature search yielded 1514 articles, further search through reference lists generated additional 40 records. To ascertain consistency and accuracy with the objective of our review, a thorough screening was done on the articles before a decision was made to include them in the thematic analysis, this ensured that only articles that specifically met the eligibility criteria were considered for inclusion. The authors began by checking the titles and abstracts of each selected article eliminating 352 records, only the relevant studies were selected (380 studies). A more detailed full-text screening was performed on the remaining articles resulting in the final inclusion list of records, the authors examined the contents in various dimensions which included checking and grouping by general study characteristics and aspects such as discussion of blockchain-based on legal and regulatory compliance from organizational or government environment; discussion of organizational change required to overcome the challenges that slowed down blockchain adoption, then the methodological aspects of the articles and finally the themes presented by each publication. Only 19 studies that met the full eligibility criteria were included for data extraction for thematic analysis (Figure 1).

Thematic analysis enables the presentation of qualitative data in a descriptive manner which help the researchers to establish and analyze themes across the studies in a comprehensive and analytic manner. In this accord, this SLR research adopted a thematic content analysis approach to identify and categorize common themes from the relevant literature. The reviewer then adopted a qualitative analysis method of narrative analysis to help classify and synthesize the retrieved data. The narrative synthesis approach combines the findings from relevant articles quantitatively and narratively summarizes each thematic issue into a more extensive and meaningful presentation.

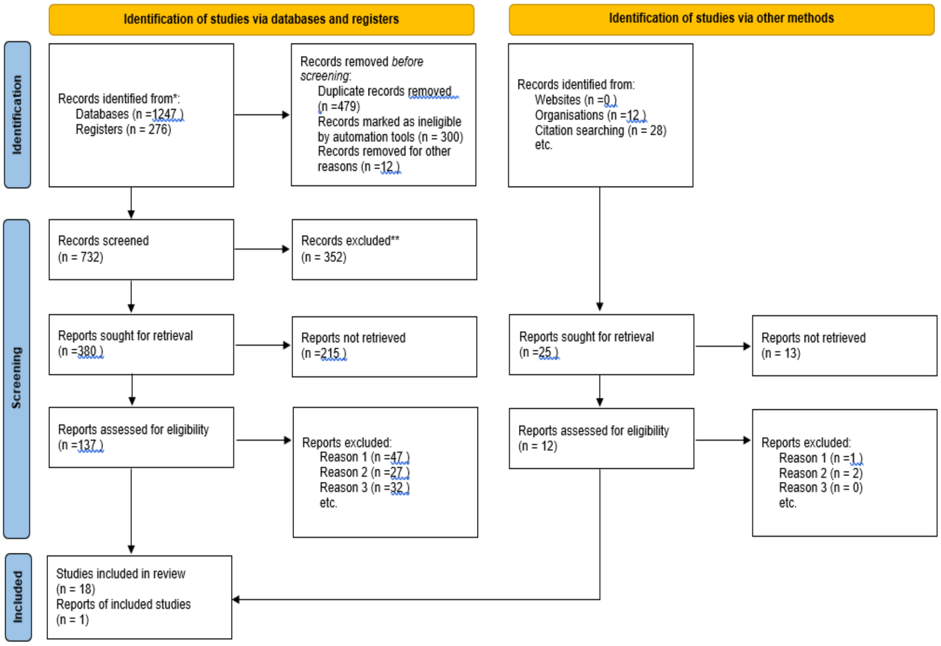

Figure 1: PRISMA Flow of Study Selection Process

3.2 The Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)

The Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) is a widely applied multi-criteria decision-making (MCDM) method that ranks a set of alternatives based on their geometric distance to an ideal solution (best-case scenario) and an anti-ideal solution (worst-case scenario), TOPSIS assumes that the most desirable alternative is the one that simultaneously minimizes the distance to the ideal solution and maximizes the distance from the anti-ideal (Hwang et al., 1981). The method involves six clear steps: constructing a decision matrix, normalizing the matrix, applying weights to criteria, identifying ideal and anti-ideal solutions, calculating the Euclidean distances from each, and computing the closeness coefficient (C_i) that determines the final ranking (Hwang et al., 1981). Recent studies have shown that TOPSIS remains highly relevant for strategic decision-making in complex domains especially when multiple and conflicting criteria are involved (Pandey et al., 2023). In the context of blockchain adoption where criteria such as regulatory compliance and other organizational factors involved, TOPSIS will provide a robust data-driven method to identify priorities and optimal actions.

The TOPSIS technique was chosen over the other MCDM techniques due to its computational efficiency and adaptability to real-world problems with quantifiable expert input. For instance, while AHP (Analytic Hierarchy Process) is widely used it becomes less practical as the number of alternatives and criteria increases due to its reliance on pairwise comparisons which can introduce subjectivity and inconsistency (Demir, 2025). In contrast, TOPSIS can handle larger datasets with less cognitive load on respondents. Furthermore, VIKOR and ELECTRE methods although they are powerful their method requires more complex assumptions and thresholds that make them harder to interpret by stakeholders unfamiliar with MCDM modeling (Kahraman et al., 2015). Recent literature also highlights that TOPSIS offers greater interpretability and ease of integration in digital tools and decision support systems which is a major advantage in public policy and technology adoption scenarios (Pandey et al., 2023).

4. Result and Discussion

This chapter presents the main findings of the study and discusses their implications, it builds on the results of the systematic literature review and the TOPSIS analysis, which were used to identify and prioritize key challenges to blockchain adoption, particularly those related to organizational change and legal compliance. The discussion explores how these challenges influence adoption efforts and reflects on their broader relevance to research and practice.

4.1 Systematic Literature Review (SLR)

This section summarizes the study findings based on the thematic synthesis of the included articles; the findings were extracted based on a comprehensive investigation of the selected articles published between 2019 and 2024 (Table 3).

4.1.1 Characteristics of Selected Articles

Although our search criteria drew studies published within the past 10 years, more attention was paid to the most recent studies. A summary of each study based on specific factors addressed and categorized based on the research objective is detailed in Table 3.

Table 3: Characteristics of Selected Articles

Study	Industry	Research Type	Focus	Key Finding
(Zhuang et al., 2020)	Healthcare	Qualitative	Compliance	Compliance with health information exchange frameworks.
(Truong et al., 2019)	Service Providers	Qualitative	Compliance	The blockchain infrastructure can verify and endorse a service provider's full alignment with GDPR regulations.
(Zghaibeh et al., 2020)	Healthcare	Qualitative	Compliance	A distributed database enables all stakeholders to access health-related data transparently without jeopardizing its authenticity.
(Liu et al., 2019)	General	Qualitative	Compliance	Blockchain allowed patients to conduct mutual authentication and create sessions keys for communication about illness.
(Rajput et al., 2019)	General	Qualitative	Compliance	The framework has been experimentally proven to deliver greater efficiency than traditional emergency access systems.
(Epiphaniou et al., 2020)	Supply Chain	Qualitative	Compliance	Encrypted data is safely distributed across Cydon's network of nodes with an uninterrupted chain of custody preserved at all times.
(Rien Agustin & Susilowati, 2019)	Business	Qualitative	Compliance	Blockchain technology supports good corporate governance mechanism.

Table 3: Characteristics of Selected Articles (Continued…)

Study	Industry	Research Type	Focus	Key Finding
(Chowdhury et al., 2023)	General	Quantitative	Challenges	Finding suggest that understanding benefits of BT, involving the team and user-friendly implementation are key.
(Janssen et al., 2020)	General	Quantitative	Challenges	Lack of expected socio-economic value of blockchain impeded blockchain adoption.
(Choi et al., 2020)	General	Quantitative	Challenges	Barriers stemming from organizational structures, environmental factors, and government regulations related to system implementation.
(Singh et al., 2023)	Supply Chain Projects	Quantitative	Challenges	Inadequate knowledge and employee training, as well as contractual risks were barrier issues to blockchain adoption.
(Kumar Bhardwaj et al., 2021)	SMEs	Quantitative	Challenges	The adoption of the technology was mainly hindered by its technological complexity and cost-related issues. Moreover, concerns about security, ease of use, and regulatory backing did not significantly affect adoption intentions.
(Dehghani et al., 2022)	General	Qualitative	Challenges	The intention to adopt blockchain is positively influenced by perceived interoperability and data quality, while perceived technological volatility and regulatory challenges hinder adoption.
(Iftikhar et al., 2021)	General	Quantitative	Challenges	Findings from the study suggest that technology adoption is driven by a combination of technological, organizational, and environmental considerations.
(Treiblmaier et al., 2021)	General	Qualitative	Challenges	A lack of comprehension regarding the technology and its advantages was a significant organizational barrier.
(Chowdhury et al., 2023)	General	Quantitative	Challenges	Adoption was positively influenced by awareness of blockchain benefits, resilient organizational engagement, and intuitive implementation, while key barriers included organizational resilience constraints and weak managerial intent.
(Kamble et al., 2020)	Supply Chain	Qualitative	Challenges	Findings imply that perceive blockchain adoption was hindered by perceived insecurity and discomfort due to the change process.
(Toufaily et al., 2021)	General	Quantitative	Challenges	Expected socio-economic value was found to impede blockchain adoption.
(Chillakuri & Attili, 2022)	HR	Qualitative	Challenges	Study suggests that the use cases building blocks are worth considering to enable the seamless adoption of the blockchain system into the HR department for the change management process.

4.1.2 Findings on Thematic Synthesis

This section addresses blockchain technology's compliance with the rules and regulations that govern its use, particularly in the context of project management across various industries such as healthcare, finance, and construction. Several reviewed articles explore how blockchain adoption aligns with regulatory frameworks, aiming to present it as a technology grounded in legal compliance by highlighting best practices that support its industrial implementation. In addition, the selected articles include a systematic examination of key challenges related to change management during blockchain adoption, focusing on design elements that facilitate successful integration with human resources management and organizational culture to support effective change management processes.

In Zhuang et al. (2020)study "health information exchange (HIE)" remarkably reaps significant benefits for patients by not only enhancing the quality of healthcare but also expediating coordinated care. However, the study notes multiple barriers to a patient-centric HIE which include data inconsistency, timely access to records, and security and privacy concerns and through the blockchain's unique feature of a distributed ledger technology that is unalterable the authors attribute to the smart contract feature that is programmed to self-execute which consequently provide data security and privacy of patients and it also ensures data provenance by providing patients complete control of data records. The General Data Protection Regulation (GDPR) also grants control of personal data back to owners by putting obligations and requirements on service providers (Truong et al., 2019). However, it is almost uncertain to certifying that the service providers comply with the GDPR and it is more worrying that the data owners are unsure if the service providers comply with the GDRP and can effectively protect their personal data. Through blockchain technology's smart contract there is a decentralized mechanism for sharing data between the owners and service providers which guarantees data transparency and provenance.

Zghaibeh et al. (2020) proposed Smart-Health (SHealth), a multi-layered blockchain-based health management system integrated with permissions and privileges of entities within the system, this system also deploys a user-friendly graphical interface built on the smart contracts to initiate inquiries and requests on patient records such as appointments bookings and attendance, medical tests results, medical procedures, medication requirements, and patient history. This ensures data reliability and security against data manipulation and attacks. Similar observations are elucidated by Liu et al. (2019) for the data sharing and privacy concerns who proposed integration of blockchain technology adoption due to its features of decentralization and tamper-proof. According to the authors, blockchain complies with data security properties such as openness and temper resistance; hence, reliable for doctors to store medical data and simultaneously access patient historical data while maintaining privacy thresholds. On the same account, the study by Rajput et al. (2019) opines that personal health records (PHR) are vital yet private in assisting the patient. The authors proposed an emergency access control management system (EACMS) which is built on permissioned blockchain hyper-ledger composer and fabric concept and through the smart contracts' capabilities, it defined rules through which patients were able to assign limitations for personal data control and permissions.

According to Epiphaniou et al. (2020), Cydon a legal and regulatory-compliant system built on blockchain offers the solution by electronically regulating data sharing across the organization entities by utilizing a decentralized data management network that executes bespoke deployable applications through the searching and retrieving of algorithms, Cydon utilizes a smart distributed ledger that accords the immutability of the audit trails and history of transactions through all the supply chain data access levels, the authors suggested that the system assured fast and authorized access to secure distributed information that guarantee its compliance with data safety and security measures. In addition, Rien Agustin and Susilowati (2019) while contributing to corruption prevention via blockchain technology, they noted that blockchain could support good corporate governance. Based on their findings, blockchain's feature that prevents third-party intervention can significantly minimize agency conflict arising from information asymmetry also blockchain limits the power disparity between the government and citizens or stakeholders. By supporting good corporate governance, blockchain is believed to comply with the rules of the social contract by preventing corruption and promoting good governance to ensure that society is in accordance with rules and morals of behavior.

Chowdhury and colleagues are of the opinion that the unique impacts of blockchain technology implementation attributes to its capabilities to accord data reliability and accuracy during transactions which make it more attractive to enhance transparency and quick decision making in projects (Chowdhury et al., 2023).The study suggested that understanding the benefits of blockchain technology alongside the user-friendliness of the technology and non-involvement in resilient organizational practices were major issues that potentially impede the successful integration of blockchain technology. Chowdhury et al. (2023) further proposed including a decision framework for assessing the sustainability and feasibility of the design cues of blockchain technology to mediate its acceptance by the project operational managers. In another study that assessed the framework of blockchain technology adoption through the specks of challenges and expected value, (Toufaily et al., 2021) identified a framework composed of environmental, technological, and organizational challenges during adoption. Hence, the study highlighted the expected socio-economic value at the ecosystem level from the multi-shareholder perspective and end-user challenges as potential issues that barred the organizational change process during blockchain adoption. The study revealed that project managers viewed blockchain as infant technology; hence, concerns arose against its technical immaturity and lack of a definite business framework.

Nevertheless, Choi et al. (2020) in trying to unravel what prevents a business from incorporating blockchain into their organizational supply chain operations, a confirmatory factor analysis study identified various factors which include environmental and organizational constraints, system-related governmental factors and environmental dimensions to impede blockchain technology adoption. From a technological context, higher complexity and high implementation costs attenuated blockchain adoption and therefore leading to high resistance to its integration in the project management change processes. At the organizational level, the workforce limited technological knowledge, including lack of awareness by the management teams and low expertise and technical know-how were elucidated as potential challenges for blockchain that lead to its unsuccessful integration into the organization's project culture and human resource dynamics. Finally, in the environmental context, the perceived constraints on government support and efficient technological infrastructure are the major determinants for the resistance in integrating blockchain into the organizational project management activities.

In another study contextualized in the construction industry, findings by Singh et al. (2023) suggest that the high sustainability maintenance costs and market-based knowledge of usage is negatively influenced blockchain adoption in the supply chain management of construction industry projects. Moreover, Kumar Bhardwaj et al. (2021) examined potential barriers in the context of small and medium enterprises (SMEs), the findings indicated that perceived usefulness, vendor support and top-management support positively mediated intentions to integrate blockchain into the SME supply chains. However, the complexity of technology concerns inhibited its adoption. Notwithstanding, Treiblmaier et al. (2021), while seeking to identify intra- and inter-organizational impedance to blockchain technology adoption recognizes that businesses partaking in the current supply chain exhibit internal and external barriers while trying to adopt blockchain. The findings from the quantitative study highlighted that the lack of knowledge and technology know-how as the main barrier for blockchain integration.

In mixed-methodology research involving a qualitative survey of 25 respondents and a subsequent quantitative survey of 146 individuals,(Dehghani et al., 2022) identified many significant factors that influence blockchain technology adoption in organizational projects. According to the findings, perceived interoperability and data quality positively impacted blockchain adoption. However, the lack of technological knowledge and regulatory uncertainties on blockchain use were highlighted as key concerns for blockchain adoption. Kamble et al. (2020), by surveying 181 supply chain practitioners point that even though technological readiness index constructs (insecurity and discomfort) had insignificant influence on the perceived usability or blockchain's usefulness, the more significant factors relating to the user perceived usefulness, behavioural control, and attitudes potentially intrude organizational change management process while integrating blockchain technology to the project management system. However, the study found a negligible impact of subjective norms towards blockchain adoption behavioral intentions.

Iftikhar et al. (2021) provided insights into blockchain adoption in the higher education sector, the findings were similar to those of the included studies, supporting the idea that perceived usefulness and top management support impede higher education institutes from integrating blockchain technology into school-based projects. A research by Chillakuri and Attili (2022) attempted to broaden the understanding of blockchain technology from the human resource (HR) perspective by using cases to capture HR practitioners' knowledge. Based on the results, the study mentioned five critical use cases which arguably streamline the critical HR process which included skill mapping, certificate verification, payroll processing, data protection, and team member performance management. In this respect, the study suggests that the use cases building blocks are worth considering to enable the seamless adoption of the blockchain system into the HR department for the change management process. In the study by Janssen et al. (2020) adopting blockchain technology probably requires considering a range of factors in the design, the author exhibits that the design framework ought to capture the complex correlations between technical, institutional, and market factors to enable it to integrate into the organizational project management culture, implying that the change process is pivotal to the shape that the blockchain application within the organization takes in matters success or failed implementation.

4.1.3 Derivation of Critical Adoption Challenges from Systematic Literature Review

The selection of the five alternatives which are supporting legal and regulatory compliance, technological complexity and design misalignment, organizational resistance and workforce limitations, leadership and strategic support deficiencies, and financial and ecosystem challenges is grounded in a rigorous synthesis of findings from multiple systematic literature review (SLR) studies examining the barriers and enablers to blockchain adoption, these factors consistently emerged across a wide range of peer-reviewed research as critical determinants influencing the success or failure of blockchain implementations. Supporting legal and regulatory compliance was selected because of blockchain core capabilities that enable data immutability and automated governance through smart contracts. (Truong et al., 2019; Zhuang et al., 2020) emphasized the potential of smart contracts in healthcare and GDPR contexts, while (Zghaibeh et al., 2020) highlighted secure permissioned access systems to enhance legal adherence. Technological complexity and design misalignment is a widely reported barrier, blockchain adoption often falters when its architecture is poorly integrated with existing IT systems which make its interoperability and real-time data usage problematic. Chowdhury et al. (2023) and Janssen et al. (2020) identified the need for systems to accommodate institutional and technical integration, while (Dehghani et al., 2022; Toufaily et al., 2021) discussed how misaligned design frameworks contribute to adoption failure.

Organizational resistance and workforce limitations was selected due to the profound influence that internal dynamics such as organizational culture and change management exert on the adoption process. Choi et al. (2020) and Treiblmaier et al. (2021) pointed to a widespread lack of technical readiness and psychological resistance among staff as significant barriers. Dehghani et al. (2022) further emphasized how limited blockchain literacy impairs successful rollout, while (Chillakuri & Attili, 2022) highlighted the need for HR driven integration strategies to reduce friction and promote organizational learning. Leadership and strategic support deficiencies reflects the essential role of executive sponsorship and strategic vision. Leadership commitment is cited by Kumar Bhardwaj et al. (2021) and Iftikhar et al. (2021) as a fundamental enabler in steering blockchain initiatives, the absence of a clear strategic direction often results in underfunded pilot projects and ultimately stalled adoption. Financial and ecosystem challenges encapsulate concerns over high implementation costs and unclear economic returns. The high capital and operational expenditures associated with blockchain were flagged by (Kumar Bhardwaj et al., 2021; Singh et al., 2023). Table 4 illustrate the five selected alternatives.

Table 4: Selected Alternatives

	Alternatives	Description	References
1)	Supporting Legal and Regulatory Compliance	Blockchain's inherent features—immutability, transparency, and smart contracts—facilitate compliance with legal and regulatory standards across sectors.	(Zhuang et al., 2020) (Epiphaniou et al., 2020; Rajput et al., 2019; Rien Agustin & Susilowati, 2019; Zghaibeh et al., 2020)
2)	Technological Complexity and Design Misalignment	Blockchain's technical intricacies and poor fit with current organizational systems often hinder its adoption.	(Chowdhury et al., 2023; Dehghani et al., 2022; Janssen et al., 2020; Liu et al., 2019; Toufaily et al., 2021)

Table 4: Selected Alternatives (Continued...)

Alternatives	Description	References
3) Organizational Resistance and Workforce Limitations	Knowledge gaps, lack of training, and cultural resistance within organizations can delay or derail blockchain implementation.	(Chillakuri & Attili, 2022; Choi et al., 2020; Chowdhury et al., 2023; Dehghani et al., 2022; Kamble et al., 2020; Treiblmaier et al., 2021)
4) Leadership and Strategic Support Deficiencies	Top-level leadership and clear strategic alignment are critical, yet frequently lacking in blockchain adoption efforts.	(Iftikhar et al., 2021; Kamble et al., 2020; Kumar Bhardwaj et al., 2021)
5) Financial and Ecosystem Challenges	Cost, lack of economic clarity, and ecosystem immaturity create substantial barriers to adoption.	(Kamble et al., 2020; Kumar Bhardwaj et al., 2021; Singh et al., 2023; Toufaily et al., 2021)

4.2 Application of the TOPSIS Method

To prioritize the key blockchain adoption challenges in the organizational project management context, the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) was applied (Hwang et al., 1981; Madanchian & Taherdoost, 2023).

- Step 1: Constructing and Normalizing the Decision Matrix

A decision matrix was developed using the average scores from 19 domain experts who evaluated five alternatives representing blockchain adoption challenges across five criteria: Impact on Adoption Success, Feasibility of Implementation, Cost Implication, Time to Impact, and Stakeholder Acceptance (Table 5).

Table 5: Decision Matrix Average Scores

Alternative/Criteria	Impact	Feasibility	Cost	Time	Stakeholder
Legal & Regulatory Compliance	7.64	5.63	8.02	6.94	8.42
Tech Complexity & Design Misalignment	8.38	5.28	7.23	7.15	7.63
Org Resistance & Workforce Limitations	8.13	5.86	7.69	6.68	7.98
Leadership & Strategic Support Deficiencies	6.75	7.32	8.35	7.73	7.48
Financial & Ecosystem Challenges	7.27	6.14	6.71	6.84	7.39

The values were normalized using vector normalization to remove scale differences among the criteria (Table 6). The normalization formula is:

$$r_{ij}(x) = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} {x_{ij}}^2}}$$

Table 6: Normalizing the Decision Matrix

Alternative/Criteria	Impact	Feasibility	Cost	Time	Stakeholder
Legal & Regulatory Compliance	0.446	0.414	0.471	0.439	0.483
Tech Complexity & Design Misalignment	0.489	0.388	0.424	0.452	0.438
Org Resistance & Workforce Limitations	0.475	0.431	0.451	0.422	0.458
Leadership & Strategic Support Deficiencies	0.394	0.538	0.490	0.488	0.429
Financial & Ecosystem Challenges	0.425	0.451	0.394	0.432	0.424

Note: Leadership and Strategic Support Deficiencies received the highest normalized values in "Feasibility" (0.538) and "Time" (0.488), suggesting strong potential impact across those dimensions.

Calculate Column Denominators (Euclidean norm):

- $\sqrt{\Sigma(\text{Impact}^2)} = \sqrt{(7.64^2 + 8.38^2 + 8.13^2 + 6.75^2 + 7.27^2)} = \sqrt{288.89} \approx 16.999$
- $\sqrt{\Sigma(\text{Feasibility}^2)} = \sqrt{(5.63^2 + 5.28^2 + 5.86^2 + 7.32^2 + 6.14^2)} = \sqrt{195.13} \approx 13.964$

- $\sqrt{\Sigma(\text{Cost}^2)} = \sqrt{(8.02^2 + 7.23^2 + 7.69^2 + 8.35^2 + 6.71^2)} = \sqrt{294.86} \approx 17.165$
- $\sqrt{\Sigma(\text{Time}^2)} = \sqrt{(6.94^2 + 7.15^2 + 6.68^2 + 7.73^2 + 6.84^2)} = \sqrt{243.91} \approx 15.624$
- $\sqrt{\Sigma(\text{Stakeholder}^2)} = \sqrt{(8.42^2 + 7.63^2 + 7.98^2 + 7.48^2 + 7.39^2)} = \sqrt{304.12} \approx 17.442$

- Step 2: Constructing the Weighted Normalized Matrix

In the absence of predetermined weights from expert stakeholders each criterion was assigned an equal weight of 0.2 assuming equal importance. The normalized values were multiplied by these weights to produce the weighted normalized matrix (Table 7). Assuming equal weights for all five criteria:

$$v_{ij}(\mathrm{x}) = w_j r_{ij}(x) \qquad i = 1, \dots, m \quad ; j = 1, \dots \quad , n$$

Table 7: Normalized Values Multiplied by Weights

Alternative/Criteria	Impact	Feasibility	Cost	Time	Stakeholder
Legal & Regulatory Compliance	0.089	0.083	0.094	0.088	0.097
Tech Complexity & Design Misalignment	0.098	0.078	0.085	0.090	0.088
Org Resistance & Workforce Limitations	0.095	0.086	0.090	0.084	0.092
Leadership & Strategic Support Deficiencies	0.079	0.108	0.098	0.098	0.086
Financial & Ecosystem Challenges	0.085	0.090	0.079	0.086	0.085

Note: Legal & Regulatory Compliance achieved a weighted value of 0.097 in "Stakeholder," whereas Leadership & Strategic Support Deficiencies had 0.108 in "Feasibility."

- Step 3: Determining Positive Ideal and Negative Ideal Solutions

The positive ideal solution (A^+) was formed by taking the maximum value of each column and the negative ideal solution (A^-) by taking the minimum. These benchmarks represent the most and least desirable levels for each criterion. This step highlights the aspiration and baseline used to compute how far each alternative deviates from perfection or deficiency (Madanchian & Taherdoost, 2023). Table 8 shows the Positive Ideal (A^+) and Negative Ideal (A^-) Values.

Table 8. Positive Ideal (A^+) and Negative Ideal (A^-) Values

Criterion	Positive Ideal (A^+)	Negative Ideal (A^-)
Impact	0.098	0.079
Feasibility	0.108	0.078
Cost	0.098	0.079
Time	0.098	0.084
Stakeholder Acceptance	0.097	0.085

Note: These values will now be used in Step 4 to calculate how far each alternative is from the positive ideal and negative ideal solutions.

- Step 4: Calculating the Distance to Positive Ideal and Negative Ideal Solutions

Using Euclidean distance, the model calculated how close each alternative was to the positive ideal and negative ideal options (Table 9). This quantitative evaluation provides a geometric interpretation of each alternative's overall performance.

We calculate the Euclidean distance of each alternative to:

Positive Ideal Solution (d^+):

$$d_i^+ = \sqrt{\sum_{j=1}^{n} (v_{ij}(x) - v_j^+(x))^2}\,, \quad i = 1, \dots, m$$

Negative Ideal Solution (d^-):

$$d_i^- = \sqrt{\sum_{j=1}^{n} (v_{ij}(x) - v_j^-(x))^2}, \quad i = 1, \ldots, m$$

Table 9: Distances

Alternative	Distance to Positive Ideal (d^+)	Distance to Negative Ideal (d^-)
Legal & Regulatory Compliance	0.028	0.023
Tech Complexity & Design Misalignment	0.035	0.021
Org Resistance & Workforce Limitations	0.027	0.023
Leadership & Strategic Support Deficiencies	0.022	0.038
Financial & Ecosystem Challenges	0.033	0.014

- Step 5: Calculating the Relative Closeness Degree (C_i)

The relative closeness degree of alternatives to the ideal solution (C_i) calculation result is shown in Table 10, and it calculated by the following equation:

$$C_i = \frac{d_i^-}{(d_i^+ + d_i^-)}, \quad i = 1, \ldots, m$$

Where:

- d_i^+ = Distance to Positive Ideal
- d_i^- = Distance to Negative Ideal

Table 10: C_i Results

Alternative	d^+	d^-	Relative Closeness Degree (C_i)
Legal & Regulatory Compliance	0.028	0.023	0.446
Tech Complexity & Design Misalignment	0.035	0.021	0.377
Org Resistance & Workforce Limitations	0.027	0.023	0.455
Leadership & Strategic Support Deficiencies	0.022	0.038	0.635
Financial & Ecosystem Challenges	0.033	0.014	0.299

Note: The relative closeness degree measures how close each alternative is to the ideal solution, allowing them to be ranked accordingly. The highest C_i was for Leadership & Strategic Support Deficiencies (0.635), with Financial & Ecosystem Challenges ranking lowest at (0.299).

- Step 6: Final Ranking (Higher C_i = Better Alternative)

Based on the C_i values the final ranking of blockchain adoption challenges is illustrated in Table 11 and Figure 2:

Table 11: Blockchain Adaption Challenges Final Ranking

Rank	Alternative	C_i
1	Leadership & Strategic Support Deficiencies	0.635
2	Organizational Resistance & Workforce Limitations	0.455
3	Legal & Regulatory Compliance	0.446
4	Tech Complexity & Design Misalignment	0.377
5	Financial & Ecosystem Challenges	0.299

Note: This outcome supports the notion that regulatory frameworks, top-level leadership support, and organizational resistance and workforce limitations are among the most crucial elements for advancing blockchain in the organizational project management practices. These findings provide clear direction for policymakers and industry leaders aiming to implement blockchain in complex and highly regulated environments.

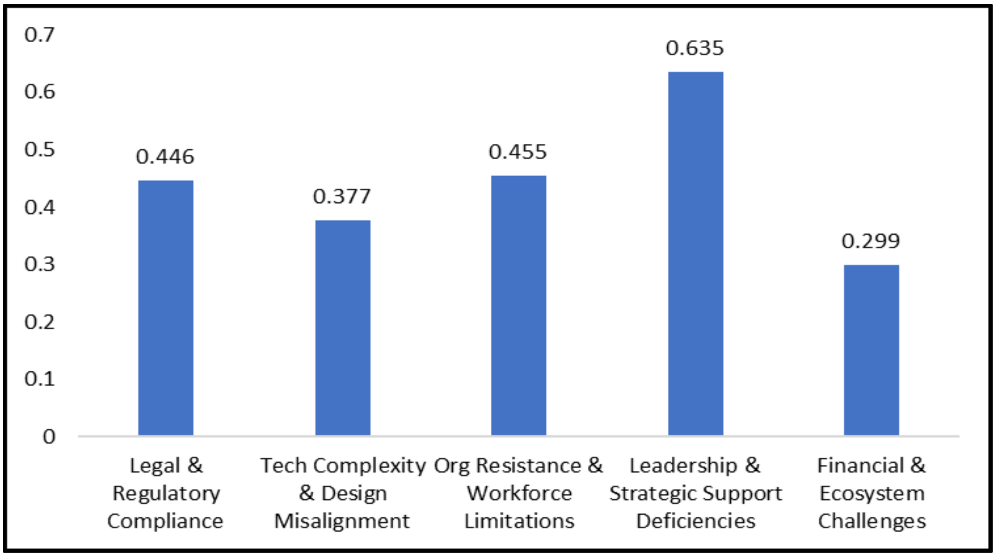

Figure 2: Ci Values

4.3 Discussion of Results

The results of the TOPSIS analysis provide a structured and data-driven prioritization of the most critical challenges hindering blockchain adoption in the organizational project management practices. The analysis revealed that "Leadership and Strategic Support Deficiencies" emerged as the top-ranked challenge (C_i = 0.635). This reflects the critical role of executive sponsorship and institutional vision in facilitating blockchain adoption. Without leadership commitment even technologically feasible solutions often stagnate due to lack of funding and prioritization (Kumar Bhardwaj et al., 2021). Iftikhar et al. (2021) demonstrates that in digital transformation projects, leadership support significantly correlates with the success of supplier and technology integration.

The "Organizational Resistance and Workforce Limitations" (C_i = 0.455) was ranked second-highest priority, underscoring the influence of internal organizational culture and human capital readiness. Resistance to new technology, lack of blockchain literacy, and unclear communication about benefits and roles can significantly impede implementation (Choi et al., 2020). As noted by Chillakuri and Attili (2022), human-centric challenges often outweigh technical ones in the early stages of digital technology adoption, workforce development initiatives such as blockchain-specific training and HR policy alignment are recommended to reduce friction.

The Third-highest priority identified by the model was "Legal and Regulatory Compliance" (C_i = 0.446), indicating its central role in determining whether blockchain solutions can be effectively and sustainably deployed. This finding aligns with several recent studies that emphasize the necessity of a robust regulatory framework to enable legal enforceability and stakeholder confidence in blockchain systems (Truong et al., 2019; Safari, 2022). Research by Zghaibeh et al. (2020) and Epiphaniou et al. (2020) also highlights that blockchain's value proposition is closely tied to its ability to enforce compliance and traceability through immutability and programmable logic. For blockchain technologies to transition from pilot projects to operational reality there must be clear legal standards addressing issues such as data privacy and jurisdiction.

The “Technological Complexity and Design Misalignment” (C_i = 0.377) was placed fourth, suggesting that while technical challenges such as system integration and scalability are still relevant they may not be as urgent as legal, strategic, or cultural concerns. This contrasts with many technology-centric perspectives but supports a more holistic view that successful adoption depends less on technological perfection and more on organizational alignment and readiness (Dehghani et al., 2022). The relatively lower score may also indicate a growing maturity in blockchain platforms where modular architectures and cloud-based services are reducing perceived complexity (Chowdhury et al., 2023).

Lastly, “Financial and Ecosystem Challenges” received the lowest score (C_i = 0.299). While this may suggest that financial barriers like implementation cost and unclear ROI are perceived as less critical it does not negate their importance. Rather, it implies that these challenges may be downstream obstacles and will become relevant once the foundational regulatory and internal capacity issues are addressed. This finding is echoed by Singh et al. (2023) who argue that financial hurdles are often conditional upon policy and strategic alignment. Moreover, ecosystem limitations such as lack of interoperable infrastructure or supportive partners tend to evolve with market maturity and are less easily controlled internally.

5. Conclusion

In conclusion, the TOPSIS results not only offer a ranked list of challenges but provide a strategic blueprint for phased intervention. The findings suggest that policymakers and decision-makers should prioritize legal reforms, strategic alignment at leadership levels, and internal workforce transformation before addressing technical integration or cost concerns. This priority hierarchy is consistent with emerging frameworks on blockchain readiness and adoption maturity. As digital infrastructure and ecosystems evolve revisiting and recalibrating these priorities will remain essential. This analysis demonstrates how multi-criteria decision-making tools like TOPSIS can convert complex qualitative judgments into actionable insights, supporting more informed and effective strategy development in blockchain transformation.

6. Study Implication

The findings of this study offer significant implications for advancing the theoretical understanding of blockchain adoption within organizational project management. By highlighting the pivotal role of legal and regulatory compliance as well as leadership support, the research underscores the need for future studies to further explore the interplay between institutional frameworks and organizational readiness. Moreover, the integration of TOPSIS as a decision-making tool demonstrates the value of structured multi-criteria approaches in evaluating complex adoption challenges, suggesting that future research could benefit from combining decision analysis methods with empirical organizational assessments to develop more actionable adoption strategies.

7. Research Limitations

While the mixed-method approach combining a systematic literature review (SLR) and the TOPSIS decision-making model provides a robust framework for identifying and prioritizing key blockchain adoption challenges it is not without limitations. The reliance on a limited number of 19 peer-reviewed articles between 2019 and 2024 may restrict the comprehensiveness of the thematic synthesis, potentially omitting emerging insights from grey literature or non-English sources. Furthermore, the TOPSIS method although effective for structured prioritization it depends heavily on the subjective assignment of weights and expert judgment which may introduce bias or overlook the dynamic contextual factors influencing blockchain implementation across industries. As a result, while the findings offer valuable guidance they should be interpreted with caution and supplemented by empirical validation through primary data collection in future studies.

8. Future Works

Future research should aim to empirically validate the prioritization of blockchain adoption challenges identified in this study by engaging with industry stakeholders through case studies, expert interviews, or large-scale surveys. Additionally, there is scope to expand the current analysis by incorporating other decision-making methods, such as fuzzy TOPSIS or DEMATEL to account for uncertainty and interdependencies among criteria. Further investigation is also needed into sector-specific adoption barriers, particularly in underexplored industries like construction or public administration to develop tailored strategies for successful blockchain integration. Finally, examining the evolving impact of policy changes and technological advancements on organizational adoption readiness would provide deeper insight into dynamic implementation contexts.

CREDIT Author Statement

All of the following authors have read and approved the final work:

- Mohamed Al Ali: Conceptualization, Data curation, Formal analysis, Methodology, Resources, Software, Writing – original draft.
- Mohammad Khadem: Supervision, Visualization, Project administration, Writing – review & editing.

Declaration of Funding

Financial independence was maintained throughout the entirety of this research. The study received no support from external funding agencies or organizations and all related tasks were performed solely by the authors.

Declaration of Competing Interest

The authors declare no conflicts of interest or affiliations that could have influenced the objectivity or integrity of this research.

Data Avalability

The data underlying this study are available from the corresponding author Mohamed Al Ali (U20105296@sharjah.ac.ae), upon reasonable request and in accordance with applicable data-sharing policies and institutional guidelines.

Institutional Review Board Statement

"Not applicable."

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Appendix 1 (Experts)

The focus is in identifying experts as a sample to provide information on the research subject while acting as representatives among top management teams within firms. To effectively carry out research and ensure the trustworthiness of the research, expert knowledge is crucial in picking respondents capable of providing vital information on integrating blockchain into project management practices. Accordingly, the survey sample will include managers from 19 government and private organizations. Given the experience and expertise of the selected respondents, these individuals will likely provide good insights into the challenges in utilizing blockchain in project management within top management teams of organizations.

The below table provides a detailed overview of 19 experts in project management and blockchain technology, it categorizes each expert by their position, age, years of experience, and whether they are employed in the private or public sector.

Table. Interview Participant Details

#	Position	Age	Years of Experience	Sector
1	Senior Blockchain Developer	45	20	Private
2	Project Manager	38	15	Public
3	Blockchain Consultant	34	10	Private
4	Technical Program Manager	42	18	Public
5	Lead Blockchain Architect	37	12	Private
6	Director of Project Management	50	25	Public
7	Blockchain Analyst	29	7	Private
8	Senior Project Coordinator	48	23	Public
9	Blockchain Specialist	36	13	Private
10	Project Lead	31	9	Public
11	Blockchain Researcher	40	15	Private
12	Portfolio Manager	46	21	Public
13	Head of Blockchain Innovation	41	17	Public
14	Blockchain Developer	39	14	Private
15	Project Management Consultant	47	22	Public
16	Deputy Project Manager	30	8	Private
17	VP of Technology	52	28	Public
18	Blockchain Strategist	35	12	Private
19	Program Director	43	20	Public

Appendix 2 (Detailed Calculation "TOPSIS")

The following table shows the decision matrix.

Alternative/Criteria	Impact	Feasibility	Cost	Time	Stakeholder
Legal & Regulatory Compliance	7.64	5.63	8.02	6.94	8.42
Tech Complexity & Design Misalignment	8.38	5.28	7.23	7.15	7.63
Org Resistance & Workforce Limitations	8.13	5.86	7.69	6.68	7.98
Leadership & Strategic Support Deficiencies	6.75	7.32	8.35	7.73	7.48
Financial & Ecosystem Challenges	7.27	6.14	6.71	6.84	7.39

The following table shows the characteristics of criteria.

Criteria	Type	Weight
Legal & Regulatory Compliance	+	0.2
Tech Complexity & Design Misalignment	+	0.2
Org Resistance & Workforce Limitations	+	0.2
Leadership & Strategic Support Deficiencies	+	0.2
Financial & Ecosystem Challenges	+	0.2

STEP 1: Normalize the decision-matrix.

$$r_{ij}(x) = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}{}^2}}$$

Where x_{ij} is the original score of alternative i for criterion j in the decision matrix.

Where $\sqrt{\sum_{i=1}^{m} x_{ij}{}^2}$ the sum of the squares of all values under criterion j.

i =1 to m: all alternatives (rows) in the decision matrix.

To find the denominators ($\sqrt{\sum_{i=1}^{m} x_{ij}{}^2}$)

$\sqrt{\Sigma(\text{Impact}^2)} = \sqrt{(7.64^2 + 8.38^2 + 8.13^2 + 6.75^2 + 7.27^2)} = \sqrt{288.89} \approx 16.999$

$\sqrt{\Sigma(\text{Feasibility}^2)} = \sqrt{(5.63^2 + 5.28^2 + 5.86^2 + 7.32^2 + 6.14^2)} = \sqrt{195.13} \approx 13.964$

$\sqrt{\Sigma(\text{Cost}^2)} = \sqrt{(8.02^2 + 7.23^2 + 7.69^2 + 8.35^2 + 6.71^2)} = \sqrt{294.86} \approx 17.165$

$\sqrt{\Sigma(\text{Time}^2)} = \sqrt{(6.94^2 + 7.15^2 + 6.68^2 + 7.73^2 + 6.84^2)} = \sqrt{243.91} \approx 15.624$

$\sqrt{\Sigma(\text{Stakeholder}^2)} = \sqrt{(8.42^2 + 7.63^2 + 7.98^2 + 7.48^2 + 7.39^2)} = \sqrt{304.12} \approx 17.442$

To find the normalized matrix (r_{ij}) divide the nominators (x_{ij}) by the denominators ($\sqrt{\sum_{i=1}^{m} x_{ij}{}^2}$).

Alternative/Criteria	Impact	Feasibility	Cost	Time	Stakeholder
Legal & Regulatory Compliance	7.64/16.999	5.63/13.964	8.02/17.165	6.94/15.624	8.42/17.442
Tech Complexity & Design Misalignment	8.38/16.999	5.28/13.964	7.23/17.165	7.15/15.624	7.63/17.442
Org Resistance & Workforce Limitations	8.13/16.999	5.86/13.964	7.69/17.165	6.68/15.624	7.98/17.442
Leadership & Strategic Support Deficiencies	6.75/16.999	7.32/13.964	8.35/17.165	7.73/15.624	7.48/17.442
Financial & Ecosystem Challenges	7.27/16.999	6.14/13.964	6.71/17.165	6.84/15.624	7.39/17.442

The following table shows the normalized matrix.

Alternative/Criteria	Impact	Feasibility	Cost	Time	Stakeholder
Legal & Regulatory Compliance	0.446	0.414	0.471	0.439	0.483
Tech Complexity & Design Misalignment	0.489	0.388	0.424	0.452	0.438
Org Resistance & Workforce Limitations	0.475	0.431	0.451	0.422	0.458
Leadership & Strategic Support Deficiencies	0.394	0.538	0.49	0.488	0.429
Financial & Ecosystem Challenges	0.425	0.451	0.394	0.432	0.424

STEP 2: Calculate the weighted normalized decision matrix.

According to the following formula, the normalized matrix is multiplied by the weight of the criteria.

$$v_{ij}(\text{x}) = w_j r_{ij}(x) \qquad i = 1, \dots, m \ \ ; j = 1, \dots \ \ , n$$

To find the weighted normalized decision matrix (v_{ij}(x)) multiply each normalized matrix ($r_i(x)$) by the criteria weight (w_j).

Alternative/Criteria	Impact	Feasibility	Cost	Time	Stakeholder
Legal & Regulatory Compliance	0.446*0.2	0.414*0.2	0.471*0.2	0.439*0.2	0.483*0.2
Tech Complexity & Design Misalignment	0.489*0.2	0.388*0.2	0.424*0.2	0.452*0.2	0.438*0.2
Org Resistance & Workforce Limitations	0.475*0.2	0.431*0.2	0.451*0.2	0.422*0.2	0.458*0.2
Leadership & Strategic Support Deficiencies	0.394*0.2	0.538*0.2	0.49*0.2	0.488*0.2	0.429*0.2
Financial & Ecosystem Challenges	0.425*0.2	0.451*0.2	0.394*0.2	0.432*0.2	0.424*0.2

The following table shows the weighted normalized decision matrix.

Alternative/Criteria	Impact	Feasibility	Cost	Time	Stakeholder
Legal & Regulatory Compliance	0.089	0.083	0.094	0.088	0.097
Tech Complexity & Design Misalignment	0.098	0.078	0.085	0.09	0.088
Org Resistance & Workforce Limitations	0.095	0.086	0.09	0.084	0.092
Leadership & Strategic Support Deficiencies	0.079	0.108	0.098	0.098	0.086
Financial & Ecosystem Challenges	0.085	0.09	0.079	0.086	0.085

STEP 3: Determine the positive ideal and negative ideal solutions.

The aim of the TOPSIS method is to calculate the degree of distance of each alternative from positive and negative ideals. Therefore, in this step, the positive and negative ideal solutions are determined according to the following formulas.

$A^+ = (v_1^+, v_2^+, \ldots, v_n^+)$

$A^- = (v_1^-, v_2^-, \ldots, v_n^{-+})$

Where

A^+: Positive Ideal Solution – the best value for each criterion.

A^-: Negative Ideal Solution – the worst value for each criterion.

v_j^+: Ideal (best) value for criterion *j*.

v_j^-: Anti-ideal (worst) value for criterion *j*.

So that

$v_j^+ = \{(max\ v_{ij}(x) \mid j \epsilon j_1), (min\ v_{ij}(x) \mid j \epsilon j_2)\}\ i = 1, \ldots, m$

$v_j^- = \{(min\ v_{ij}(x) \mid j \epsilon j_1), (max\ v_{ij}(x) \mid j \epsilon j_2)\}\ i = 1, \ldots, m$

Where

j1 and j2 denote the negative and positive criteria, respectively.

$v_{ij}(x)$: The weighted normalized value for alternative iii and criterion *j*.

v_j^+: The best (ideal) value for criterion *j* across all alternatives.

v_j^- : The worst (anti-ideal) value for criterion j.

j_1: Set of indices for positive criteria (where higher values are preferred).

j_2: Set of indices for cost negative criteria (where lower values are preferred).

Alternative/Criteria	Impact	Feasibility	Cost	Time	Stakeholder
Legal & Regulatory Compliance	0.089	0.083	0.094	0.088	0.097
Tech Complexity & Design Misalignment	0.098	0.078	0.085	0.09	0.088
Org Resistance & Workforce Limitations	0.095	0.086	0.09	0.084	0.092
Leadership & Strategic Support Deficiencies	0.079	0.108	0.098	0.098	0.086
Financial & Ecosystem Challenges	0.085	0.09	0.079	0.086	0.085
Positive Ideal (A^+)	0.098	0.108	0.098	0.098	0.097
Negative Ideal (A^-)	0.079	0.078	0.079	0.084	0.085

STEP4: Distance from the positive and negative ideal solutions.

TOPSIS method ranks each alternative based on the relative closeness degree to the positive ideal and distance from the negative ideal. Therefore, in this step, the calculation of the distances between each alternative and the positive and negative ideal solutions is obtained by using the following formulas.

Positive Ideal Solution (d^+):

$$d_i^+ = \sqrt{\sum_{j=1}^{n} (v_{ij}(x) - v_j^+(x))^2}\,, \quad i = 1, \dots, m$$

Negative Ideal Solution (d^-):

$$d_i^- = \sqrt{\sum_{j=1}^{n} (v_{ij}(x) - v_j^-(x))^2}\,, \quad i = 1, \dots, m$$

Where

d_i^+: Distance of alternative i from the positive ideal solution (PIS).

d_i^-: Distance of alternative i from the negative ideal solution (NIS).

$(v_{ij}(x)$: Weighted normalized value of alternative iii with respect to criterion j.

$v_j^+(x)$: Best value (positive ideal) for criterion j.

$v_j^-(x)$: Worst value (negative ideal) for criterion j.

n: Total number of criteria.

m: Total number of alternatives.

i: Index of the alternative (1 to m).

j: Index of the criterion (1 to n).

To find the Positive Ideal Solution (d_i^+):

√Σ(Legal & Regulatory Compliance^2) = √ $(0.089\text{-}0.098)^2 + (0.083\text{-}0.108)^2 + (0.094\text{-}0.098)^2 + (0.088\text{-}0.098)^2 + (0.097\text{-}0.097)^2$ =0.028

√Σ(Tech Complexity & Design Misalignment^2) = √ $(0.098\text{-}0.098)^2 + (0.078\text{-}0.108)^2 + (0.085\text{-}0.098)^2 + (0.09\text{-}0.098)^2 + (0.088\text{-}0.097)^2$ = 0.035

√Σ(Org Resistance & Workforce Limitations^2) = √ $(0.095\text{-}0.098)^2 + (0.086\text{-}0.108)^2 + (0.09\text{-}0.098)^2 + (0.084\text{-}0.098)^2 + (0.092\text{-}0.097)^2$ = 0.027

√Σ(Leadership & Strategic Support Deficiencies^2) = √ $(0.079\text{-}0.098)^2 + (0.108\text{-}0.108)^2 + (0.098\text{-}0.098)^2 + (0.098\text{-}0.098)^2 + (0.086\text{-}0.097)^2$ = 0.022

√Σ(Financial & Ecosystem Challenges^2) = √ $(0.085\text{-}0.098)^2 + (0.09\text{-}0.108)^2 + (0.079\text{-}0.098)^2 + (0.086\text{-}0.098)^2 + (0.085\text{-}0.097)^2$ = 0.033

To find the Negative Ideal Solution (d_i^-):

√Σ(Legal & Regulatory Compliance^2) = √ $(0.089\text{-}0.079)^2 + (0.083\text{-}0.078)^2 + (0.094\text{-}0.079)^2 + (0.088\text{-}0.084)^2 + (0.097\text{-}0.085)^2$ = 0.023

√Σ(Tech Complexity & Design Misalignment^2) = √ $(0.098\text{-}0.079)^2 + (0.078\text{-}0.078)^2 + (0.085\text{-}0.079)^2 + (0.09\text{-}0.084)^2 + (0.088\text{-}0.085)^2$ = 0.021

√Σ(Org Resistance & Workforce Limitations^2) = √ $(0.095\text{-}0.079)^2 + (0.086\text{-}0.078)^2 + (0.09\text{-}0.079)^2 + (0.084\text{-}0.084)^2 + (0.092\text{-}0.085)^2$ = 0.023

√Σ(Leadership & Strategic Support Deficiencies^2) = √ $(0.079\text{-}0.079)^2 + (0.108\text{-}0.078)^2 + (0.098\text{-}0.079)^2 + (0.098\text{-}0.084)^2 + (0.086\text{-}0.085)^2$ = 0.038

√Σ(Financial & Ecosystem Challenges^2) = √ $(0.085\text{-}0.079)^2 + (0.09\text{-}0.078)^2 + (0.079\text{-}0.079)^2 + (0.086\text{-}0.084)^2 + (0.085\text{-}0.085)^2$ = 0.014

The following table shows the distance to the positive and negative ideal solutions.

Alternative/Criteria	Distance to Positive Ideal (d^+)	Distance to Negative Ideal (d^-)
Legal & Regulatory Compliance	0.028	0.023
Tech Complexity & Design Misalignment	0.035	0.021
Org Resistance & Workforce Limitations	0.027	0.023
Leadership & Strategic Support Deficiencies	0.022	0.038
Financial & Ecosystem Challenges	0.033	0.014

STEP 5: Calculate the relative closeness degree of alternatives to the ideal solution

In this step, the relative closeness degree of each alternative to the ideal solution is obtained by the following formula. If the relative closeness degree has value near to 1, it means that the alternative has shorter distance from the positive ideal solution and longer distance from the negative ideal solution.

$$C_i = \frac{d_i^-}{(d_i^+ + d_i^-)} \quad , \quad i = 1, \dots, m$$

Where

C_i: Relative closeness of alternative i to the ideal solution.

d_i^+: Distance of alternative i from the positive ideal solution (PIS).

d_i^-: Distance of alternative i from the negative ideal solution (NIS).

i: Index of the alternative, where $i = 1, \ldots, m$

m: Total number of alternatives.

The following table shows the relative closeness degree of each alternative (C_i).

Alternative/Criteria	d^+	d^-	$C_i = \frac{d_i^-}{(d_i^+ + d_i^-)}$	(C_i)
Legal & Regulatory Compliance	0.028	0.023	0.023/(0.028+0.023)	0.446
Tech Complexity & Design Misalignment	0.035	0.021	0.021/(0.035+0.021)	0.377
Org Resistance & Workforce Limitations	0.027	0.023	0.023/(0.027+0.023)	0.455
Leadership & Strategic Support Deficiencies	0.022	0.038	0.038/(0.022+0.038)	0.635
Financial & Ecosystem Challenges	0.033	0.014	0.014/(0.033+0.014)	0.299

Step 6: Final Ranking (Higher C_i = Better Alternative)

The following table shows the final ranking.

Rank	Alternative	C_i
3	Legal & Regulatory Compliance	0.446
4	Leadership & Strategic Support Deficiencies	0.377
2	Organizational Resistance & Workforce Limitations	0.455
1	Tech Complexity & Design Misalignment	0.635
5	Financial & Ecosystem Challenges	0.299