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# Strategic Factors for Blockchain Implementation in Supply Chains

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**Abstract**

This study identifies twelve critical factors influencing the successful implementation of Blockchain Technology (BCT) in supply chain processes, addressing the significant gap in understanding the practical and theoretical complexities of blockchain implementation. Through semi-structured interviews and grounded theory analysis, the concept of Decentralized Coordination and Sustainability was derived in addition to themes such as Strategic Alignment and Leadership Commitment, Organizational Adaptability and Resilience, Data Security and Integrity, User Preparedness and Engagement. These themes provide a novel theoretical lens to explore blockchain's role in enhancing supply chain transparency, traceability, and collaboration. The study bridges strategic frameworks with decentralized technologies, providing actionable insights for successful implementation in the supply chain discipline. This research advances the application of grounded theory in blockchain research, encouraging qualitative methods to explore emerging technologies within complex organizational systems. This study establishes a foundation for future research to enhance our understanding of blockchain's transformative impact in supply chain contexts.

**Keywords:** blockchain implementation; supply chain management; grounded theory; decentralized coordination; transparency and traceability

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## 1. Introduction

Blockchain technology (BCT) offers transformative potential for supply chain management by addressing inefficiencies, lack of transparency, and stakeholder trust issues that traditional supply chain systems face (Vela, 2023). Acting as a decentralized, immutable ledger, BCT enables secure transaction tracking and data management, ensuring real-time visibility and traceability across supply chain participants (Tripathi et al., 2023; Difrancesco et al., 2022). This transparency not only boosts inventory accuracy and streamlines processes but also provides organizations with a significant competitive advantage by enhancing efficiency, trust, and responsiveness in increasingly complex global supply chains (Brasi, 2023).

The adoption of BCT in supply chains is accelerating, with global spending on blockchain solutions projected to increase from $5.3 billion in 2021 to $34 billion by 2026 (Deloitte Insights, 2021). Technologies like blockchain are increasingly integrated with the Internet of Things (IoT) and Artificial Intelligence (AI), enabling organizations to further enhance supply chain resilience and data-driven decision-making (Gartner, 2024).

Blockchain enables advancements in the supply chain by supporting use cases such as enhanced product tracking, fraud prevention, and automated inventory management

through smart contracts, positioning it as a technology with significant potential to redefine traditional supply chain operations (Deloitte Insights, 2021). Blockchain's tamper-resistant system enhances traceability, providing a transparent record of each inventory movement, which supports efficient product lifecycle tracking and fraud prevention (Deloitte Insights, 2021). BCT also aids demand forecasting, allowing for automatic reordering via smart contracts to prevent inventory imbalances (Gohil & Thakker, 2021). Collaborative blockchain data sharing among supply chain stakeholders ensures data accuracy, reduces disputes, and minimizes delays (Xia et al., 2023).

The rapid adoption rate of BCT in supply chain systems highlights BCT's increasing importance in addressing key supply chain challenges. Gartner forecasts that the business value generated by blockchain will grow rapidly, reaching $176 billion by 2025 and $3.1 trillion by 2030 (Kandaswamy et al., 2018).

As global supply chains evolve, the implementation of BCT touts a solution that addresses fundamental inefficiencies and risks related to transparency, can potentially reduce costs across the supply chain network, and address product issues such as provenance, sustainability, and compliance challenges. By integrating IoT with BCT, Walmart and IBM's blockchain platforms cut food trace times from weeks to seconds (Kandaswamy et al., 2018; Fujitsu, 2024), demonstrating the quantitative benefits of adopting BCT. The use of the distributed ledger within BCT allows organizations to track environmental impact, including carbon emissions and sourcing of raw materials, aligning with increasing ESG (Environmental, Social, and Governance) priorities (Fujitsu, 2024). Organizations are leveraging BCT to secure a sustainable competitive advantage and thrive in the future digital economy (Deloitte Insights, 2021).

Practical implementation of blockchain remains a significant challenge for many organizations. Despite its strategic potential, the implementation of BCT in the Supply Chain Domain lacks robust theoretical foundations. Organizational theories and technology adoption theories facilitate an understanding of the intersection of BCT in the Supply Chain domain (Kummer et al., 2020).

Despite its promise, BCT has not been fully integrated into supply chain operations due to several barriers, including technological complexity, cost considerations, and organizational resistance (Kummer et al., 2020). Models like TAM, UTAUT, and the TOE framework, commonly used in technology adoption, help identify factors affecting blockchain adoption and offer strategies to optimize user acceptance (Clohessy et al., 2018; Francisco & Swanson, 2018). While these models have been applied to understand technology adoption in general, blockchain's decentralized nature introduces unique challenges that existing frameworks have not explored.

The success of blockchain implementation is not solely dependent on technological adoption but also on strategic alignment, stakeholder engagement, and overcoming institutional barriers, which require a deeper understanding of both individual and organizational factors (Shahzad et al., 2024). For instance, issues related to interoperability, scalability, and the organizational shift required to integrate a decentralized system are unique to BCT.

While blockchain's transformative potential in enhancing transparency, traceability, and security within supply chains is widely acknowledged, and its strategic advantages of efficiency, cost reduction, and ethical sourcing are increasingly being recognized (Tsolakis et al., 2023), practical implementation of blockchain remains a significant challenge for many organizations. Despite its strategic potential, the implementation of BCT in the supply chain domain lacks robust theoretical foundations. This raises a central research question: what are the key factors that collectively influence the implementation of blockchain technology in the supply chain?

Organizational theories and technology adoption theories facilitate an understanding of the intersection of BCT in the supply chain domain (Kummer et al., 2020). Various organizational management theories, including institutional theory, transaction cost analysis, and principal-agent theory, support blockchain's role in inventory and cost management, as well as transparency (Teodorescu & Korchagina, 2021; Manupati et al., 2019). Additionally, resource-based view theories (RBV) highlight blockchain's potential in vendor-managed inventory and sustaining supply chain viability (Cammarano et al., 2023).

Despite the theoretical insights provided by the organizational management and technology adoption frameworks, the unique complexities introduced by blockchain's decentralized architecture are not addressed. These challenges underline a significant research gap: the lack of a comprehensive, blockchain-specific framework that integrates both individual and organizational factors to guide its effective implementation. This study addresses this gap by identifying 12 strategic factors that influence blockchain implementation in supply chain management, encompassing strategic, organizational, and decentralized dimensions. By deriving broader themes from these factors, such as strategic alignment, organizational adaptability, and decentralized coordination, the research provides a new theoretical lens for understanding blockchain in complex supply chain systems.

## 2. Systematic Literature Review

To establish a foundation for this study, a systematic literature review (SLR) of blockchain technology adoption and implementation in supply chain management was previously conducted by Sekar et al. (2024). The review examined studies across leading databases, synthesizing insights from organizational management theories and technology adoption frameworks. The analysis highlighted blockchain's potential to enhance transparency, traceability, and security, while also identifying persistent challenges related to scalability, interoperability, governance, and organizational readiness.

A key finding of the SLR was that, while existing studies provide valuable insights into adoption factors, they often treat blockchain as a generic information technology. This overlooks the unique complexities of blockchain's decentralized architecture, particularly in the context of supply chain systems. Thus, a clear research gap remains: the absence of a blockchain-specific framework that integrates strategic, organizational, and decentralized dimensions. Building on the SLR's findings, this study addresses this gap by identifying twelve key factors influencing blockchain implementation and developing a new theoretical lens for understanding its role in supply chains.

## 3. Materials and Methods

To address the identified research gap, this study aimed to perform an exploratory study. An exploratory study is to be used when we want to discover what is happening to gain insight into a topic and to understand a phenomenon, especially when the aim is to gain a deeper understanding of the research subject (Saunders et al., 2016; Hair et al., 2019). When evaluating an organization's successful implementation of a new technology, an established theory acts as a base for further investigation of the phenomenon. But it is always encouraged to go beyond and not be confined to the starting theory only. Researchers should be open to accepting any of the new findings coming out of the whole inquiry process. This approach, also known as theory elaboration, helps researchers to extract new insights that further extend the theory (Fisher & Aguinis, 2017). With our identified research question and the need for a deeper understanding, an exploratory study is compatible with our approach.

By examining the factors that affect BCT implementation in the Supply Chain domain, this study aims to provide a deeper understanding of the specific organizational,

strategic, and technological elements that shape blockchain initiatives within supply chain management. Additionally, the study seeks to go beyond individual factors by identifying broader themes that emerge from these factors. These themes are intended to capture the interconnected dynamics among factors, providing actionable insights that contribute to both theory and practice in the domain of blockchain implementation.

To achieve this, we employed grounded theory methodology. In grounded theory, researchers aim to develop concepts and theories that are grounded in the data collected from the research participants, rather than starting with preconceived theories. By using grounded theory, raw data can be handled with the use of several analytical tools to explore different phenomena by identifying and developing concepts (Creswell, 1998). This approach is more appropriate for discovering new and unknown relations, and to avoid any bias that might come with this. Also, grounded theory is a comprehensive method for theory generation (Glaser, 1998; Corbin & Strauss, 2008).

Analyzing the data using grounded theory methodology and the three-step coding process (Strauss & Corbin, 1990), open codes were categorized and sorted to create axial codes. Axial codes are concepts that have meaning. The concepts were further abstracted in the selective coding process to generate broad categories. As illustrated in Figure 1, the process began with data collection through interviews, followed by systematic data analysis involving open, axial, and selective coding stages, ultimately leading to the generation of key themes.

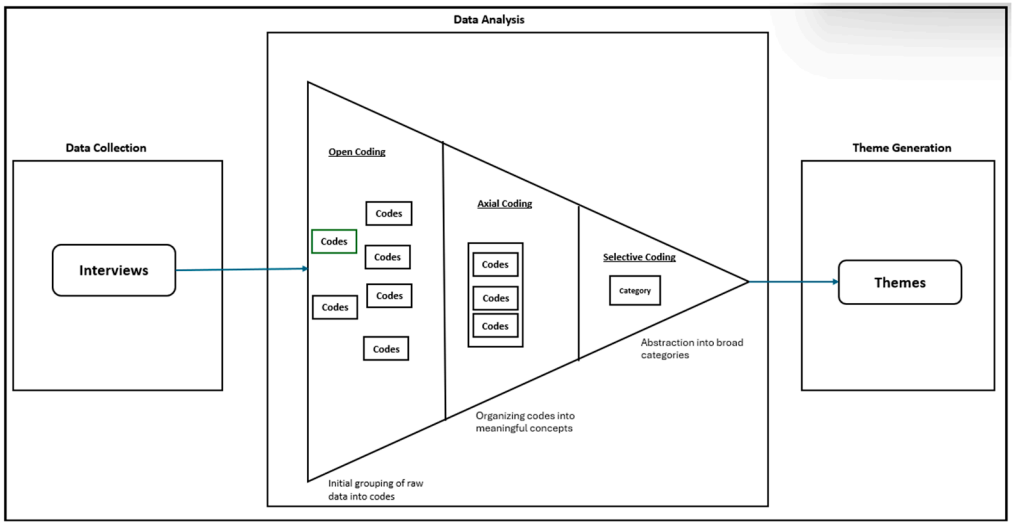


**Figure 1.** Data Analysis Framework for Blockchain Implementation Research.

These categories paved the way to identify the key factors that influence the implementation of blockchain technology in organizations, through the help of the coding instrument by Qureshi and Ünlü (2020). This instrument, Figure 2, provided structure throughout the analysis by helping identify emergent theoretical constructs and the ultimate development of the theoretical propositions.

For this research, obtaining the necessary Institutional Review Board (IRB) approvals was a critical first step. Before commencing the interviews, a detailed proposal was submitted outlining the study's objectives, methodology, and procedures to the IRB. This process ensured that all ethical considerations were addressed, including the protection of participants' rights and confidentiality. In conducting this research, we strictly adhered to IRB guidelines to ensure the protection and confidentiality of all participants. This involved assigning coded identifiers to each participant to maintain anonymity throughout the study. Additionally, all data collected were securely stored and handled following

IRB protocols, safeguarding the privacy and ethical treatment of participants. The IRB's approval confirmed that the study met ethical standards for research involving human subjects, thereby safeguarding participants and ensuring that their contributions were obtained with informed consent and treated with respect throughout the research process.

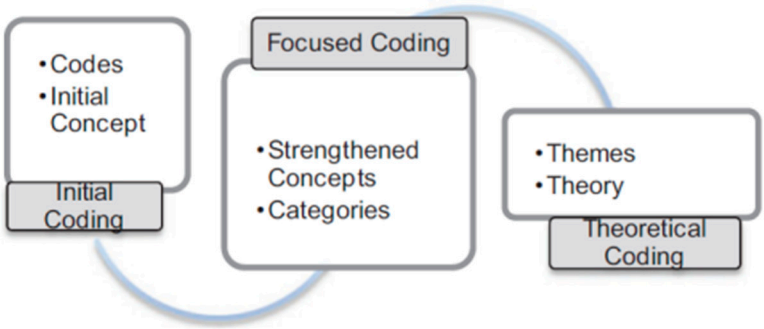


**Figure 2.** Qureshi and Unlu coding instrument (Qureshi & Ünlü, 2020).

### 3.1. Data Collection

For this study, a semi-structured, in-depth interview was chosen to enable detailed exploration. The format was based on the five phases suggested by Kallio et al. (2016) and allows probing deeper into responses for clarification, especially with complex matters (Naz et al., 2022). Interviews were designed to directly delve into nuanced details, given that the interviews were conducted with experts (Edeland & Mörk, 2018). Research participants were BCT experts selected for their supply chain background and blockchain implementation experience. This method is effective for gaining insights into complex issues through a flexible approach (Yin & Ran, 2021). Interviews were recorded, transcribed using Otter.ai, verified manually, and reviewed for accuracy.

### 3.2. Sample Size

The key to qualitative research, particularly grounded theory, is to generate enough data so patterns, concepts, categories, properties, and dimensions of the given phenomena can emerge (Corbin & Strauss, 2008). Therefore, it is essential to obtain an appropriate sample size that will generate sufficient data (Auerbach & Silverstein, 2003). This appropriate sample size is determined by the concept of 'theoretical saturation' (Corbin & Strauss, 2008). In data collection, theoretical saturation is expected to occur when: (1) no new or relevant data seem to emerge regarding a category, (2) the category is well developed in terms of its properties and dimensions demonstrating variation, and (3) the relationships among categories are well established and validated (Corbin & Strauss, 2008).

In the case of interviews, there is no set number for when theoretical saturation occurs (Strauss & Corbin, 1998; Glaser & Strauss, 1967). One of the aspects is that sample size depends on the research question (Morse, 2000; Sobal, 2001). A broader research scope will require far more data and thus require more data collection, which in turn requires more interviews, and may require alternative data sources. This means considerably more work for the researcher. Thus, Strauss and Corbin (1998) recommend narrowing the focus of the research question at the beginning or after three or four interviews. By using the first few interviews as guides to the essence of the phenomena, the researcher can narrow the focus and thus reduce the number of interviews (Strauss & Corbin, 1998).

Before beginning the main interviews, we conducted a pilot study with five participants to validate the effectiveness of our interview questions. The pilot study served as a crucial step in ensuring that our questions were adequately designed to get the necessary data for our exploration study on blockchain implementation in supply chain management.

The participants in the pilot study were selected based on their experience and knowledge of blockchain technology and supply chain processes, mirroring the profiles of the broader group of interviewees. Their feedback was instrumental in confirming that the questions were comprehensive and relevant to our research objectives.

The results of the pilot study indicated that the formulated interview questions were indeed effective in capturing detailed and meaningful insights. The participants provided rich and varied responses, which validated our assumption that the questions were well-structured and capable of addressing the research gap. With this validation, we confidently proceeded with the remaining interviews, assured that the data collected would be robust and insightful. The pilot study not only reinforced the relevance of our interview framework but also highlighted the readiness of our methodology to delve into the intricacies of blockchain implementation in supply chain management.

According to qualitative research academics, the issue of "how many" in determining the sample size is a complex topic to answer directly. It is a crucial aspect of assessing the quality and validity of qualitative research. Generally, data saturation as a principle guides data adequacy in grounded theory design (Sarfo et al., 2021).

Data saturation is determined by two types: code saturation and meaning saturation (Hennink et al., 2017). Code saturation in Grounded Theory occurs when researchers "heard it all", whereas meaning saturation could be reached when researchers "understand it all". Determining saturation points across most qualitative studies is fluid. As per Hennink et al. (2017), code saturation in Grounded Theory could be reached at nine interviews, whereas meaning saturation could be reached between 16–24 interviews. This number is ideal for capturing diverse perspectives and achieving saturation in qualitative data analysis (Aldiabat & Le Navenec, 2018). According to Thomson (2011), while saturation is expected to occur around the tenth interview, verifying saturation by doing more interviews is good.

Based on the principles of data saturation advocated by Hennink et al. (2017), (Thomson, 2011) and Sarfo et al. (2021) and the richness of the collected data, 16 semi-structured interviews were deemed sufficient for this study. In selecting blockchain implementation consultants for this study, sixteen participants were included when saturation was perceived. The primary criteria for their selection were their extensive experience and the breadth of blockchain implementations they had performed across multiple industries. Each consultant chosen for the study had successfully executed multiple blockchain implementations, which provided a wealth of practical insights, and a deep understanding of the complexities involved. By focusing on experienced consultants, we ensured that the data collected would be rich in detail, encompassing a variety of scenarios and challenges encountered in real-world applications. This diverse industry experience allowed us to capture a wide range of perspectives, making the findings more comprehensive and generalizable.

Data saturation occurs when additional interviews no longer yield new information or themes, indicating that the sample size is sufficient to capture the full scope of the phenomenon under investigation. Previous studies in qualitative research have shown that fewer than 20 interviews are typically sufficient to reach saturation, especially when the participants are highly knowledgeable and experienced in the subject matter (Crouch & McKenzie, 2006). Moreover, as per Guest et al. (2006), data saturation often occurs within the first 12 interviews, and basic themes can be identified within 6 interviews. In our case, the depth of expertise among the selected consultants ensured that even with 16 interviews, we were able to achieve a robust understanding of the key factors influencing blockchain implementation. This sample size provided a balance between depth and breadth of data, enabling a thorough exploration of the research questions.

### 3.3. Validity and Reliability

In this study, reliability was ensured through consistent methodological practices and rigorous data management processes. Semi-structured interviews were conducted using a standardized protocol, ensuring that all participants were asked similar questions to maintain consistency in data collection (Merriam & Tisdell, 2016). The grounded theory approach was applied uniformly, with systematic open, axial, and selective coding, allowing for replicable identification of themes (Miles et al., 2014). An audit trail was maintained to document all stages of the research, including data collection, coding, and thematic analysis, ensuring transparency and dependability (Lincoln & Guba, 1985).

Validity in this research was achieved through multiple strategies designed to enhance credibility, transferability, and confirmability. Verification was conducted by sharing preliminary findings with participants (member checking) to confirm that the interpretations accurately represented their experiences and perspectives (Creswell & Poth, 2018; Lincoln & Guba, 1985). To enhance credibility, interviews were conducted with the sincere intention of capturing detailed insights from experts, ensuring that findings reflected authentic perceptions (Shenton, 2004). These strategies collectively ensure that the findings of this research are credible, contextually grounded, and robust in addressing the identified research gap.

### 3.4. Data Analysis

In qualitative research, carefully examining the data is an important aspect that helps find important themes and patterns for better understanding. Data analysis was performed with the use of Atlas.ti software, version 24, where texts were analyzed and interpreted using coding and annotating activities (Friese, 2002).

The analysis of the data collected followed Corbin and Strauss's guidelines, starting with open coding to identify and categorize phenomena in the text. Relevant information was labeled and refined through axial coding, identifying relationships between labeled codes, and forming interconnected groups for analysis.

Following the grounded theory approach, a structured coding process with three stages was used: open, axial, and selective coding. The first phase, open coding, involved a close examination of the interview transcripts, during which the data were broken down into discrete segments and assigned initial codes. Each segment was coded based on recurring words, phrases, and ideas from participants, which represented different aspects of blockchain implementation. This phase generated a large set of initial codes, each highlighting an individual aspect of BCT's impact on the implementation.

During the axial coding phase, the initial open codes were carefully examined to identify relationships and commonalities. Codes representing similar concepts were grouped to form broader categories that captured major aspects of blockchain implementation, such as management support, data security, and user readiness. Through iterative refinement, these categories were consolidated into twelve higher-order factors that reflect the strategic, organizational, and decentralized dimensions of blockchain adoption in supply chain management.

Although these factors were primarily derived from the grounded analysis of expert interviews, their relevance is further supported by prior academic and industry literature. Each factor aligns with themes previously identified in the systematic literature review (Sekar et al., 2024) and is reinforced by existing studies that discuss similar challenges and enablers of blockchain implementation (e.g., Tripathi et al., 2023; Tsolakis et al., 2023; Francisco & Swanson, 2018; Clohessy et al., 2018; Kummer et al., 2020). Consequently, Table 1 presents the Factors, Definitions, and Related Codes, accompanied by representative supporting literature that substantiates the empirical findings.

**Table 1.** Factors, Definition and Related Codes.

| Factors and Definition | Related Codes |
| --- | --- |
| Decentralized Governance—System where decision-making authority is distributed across multiple nodes or participants, rather than being controlled by a central entity | Accountability in coordination across stakeholders, Balancing autonomy and coordination with collaborators, Collaboration through decentralized authority, Creating uniform goals across network participants. |
| Decentralized System Vitality—Ensuring scalability, interoperability, and sustainability are critical for maintaining the long-term viability to ensure reliable decentralized operations | Skilled blockchain technical team, Strong Technical Team, Staff capabilities increase readiness, Dedicated team with technical expertise, Solid integration with existing systems, Technology easily communicates with Legacy systems. |
| Decentralized Security and Encryption—Decentralized security and encryption involve using distributed systems and cryptographic techniques to protect data and ensure privacy without relying on a central authority. | Authorized people access, Clearly defined roles and access, Permissioned blockchain provides access controls, Permissioned blockchain restricts access, Role-based access controls, Secure platform. |
| Strategic Leadership—The commitment and guidance from top management to drive blockchain initiatives and align them with organizational goals | Clear vision, Leadership strategic objective, Leadership ensures project meets strategic objectives, Strategic alignment, Team aligned with a vision, Leadership support aligns with strategic goals, Leadership commitment to technology, allocating budget, allocating resources, better budget allocation, Leadership ensures quick decisions, Leadership commitment to technology. |
| Organizational Strategy—The alignment of blockchain initiatives with broader business objectives to support competitive advantage and long-term growth | Aligning technology with organizational goals, strategic partnership and leadership support, Prioritization of blockchain initiatives, clear risk management processes, Mitigation strategies and risk identification. |
| Future Readiness—The organization's preparedness to adapt and scale blockchain technology in response to future advancements and industry demands | Anticipating trends important for future proofing, need to be proactive with new changes, Future proofing reduces reengineering, Future proofing scalability using long-term vision. |
| Infrastructure Readiness—The availability and robustness of technical systems and resources necessary to support secure and scalable blockchain implementation | Lack of scalability affects organization growth, Lack of scalability affects organization strategies, Lack of scalability impacts production schedules, Lack of scalability increases delay, Lack of scalability leads to disruptions, Lack of scalability loses competitiveness, Poor scalability blunts strategic gains, Poor scalability hinders strategic growth, Poor scalability impacts customer. |
| Supportive Ecosystem—Network of resources, stakeholders, and conditions that enable the successful adoption and growth of a technology or initiative | Clear stakeholder collaboration, Cross-departmental collaboration, Cross-functional collaboration, Leadership creates continuous alignment for collaboration, Leadership facilitates collaboration. |
| Training and Education—Developing the skills and knowledge necessary to effectively adopt and implement new blockchain technologies or processes | Clear training and awareness, Comprehensive training, Education and training, Effective training programs, Empowering users with knowledge and skills, filing knowledge gaps, guidance and support, Guiding the design and implementation, Hands-on experience, Importance of training, invest in training and change management, Tailored documents. |
| Change Management—Process of preparing, supporting, and guiding individuals and organizations through transitions to new systems, processes, or technologies. | Adaptability to change, Organizational flexibility in adapting new protocols, Help Desk to assist users, Continuous support, Multiple training options, Constant feedback. |

**Table 1.** *Cont.*

| Factors and Definition | Related Codes |
| --- | --- |
| User Acceptance—willingness of users to adopt and effectively use the blockchain system or technology. | Clear usability and accessibility, Intuitive design, Intuitive interfaces, Technology is accessible, Technology makes users comfortable. |
| Data Management Practices—Data management practices involve the processes, policies, and tools used to collect, store, organize, and protect data throughout its lifecycle | Clearly defining sensitive data, Data anonymization increases security, Documented process handling sensitive data, Selective disclosure maintains data integrity, Secure data storage, Secure data strategies. |

*Note:* The twelve strategic factors were identified through grounded theory analysis and validated against themes identified in the prior systematic literature review (Sekar et al., 2024). This demonstrates alignment between the emergent findings and established literature on blockchain implementation in supply chains.

## 4. Results

In this section, the identification of the 12 strategic factors influencing blockchain technology implementation in supply chain management is discussed. Thematic insights derived from these factors are then presented, highlighting the critical areas that shape successful BCT implementation in supply chain systems.

### *4.1. Rationale for Identifying the 12 Strategic Factors*

The 12 factors identified were chosen based on their prominence and relevance across multiple interviewees. These factors were not only recurrent across the interviews but also provided insights into different dimensions of blockchain implementation, emphasizing the unique aspects of decentralized technology. For example, Decentralized Governance emerged as a critical factor, reflecting the need for transparent decision-making processes that empower distributed stakeholders without reliance on a central authority. Likewise, Decentralized System Vitality was highlighted for its importance in ensuring the robustness and resilience of blockchain networks in managing supply chain operations.

Additionally, Strategic Leadership was identified as a pivotal factor, with interviewees emphasizing the role of leaders in navigating the complexities of blockchain's decentralized nature. Effective leadership requires not only driving blockchain initiatives and resource allocation but also fostering collaboration across distributed teams and ensuring alignment with the decentralized structure of the technology. This highlights the shift from traditional hierarchical leadership to a model that supports autonomy and shared responsibility within a blockchain ecosystem.

The final selection of these 12 factors reflects the complex, multi-faceted nature of blockchain implementation, incorporating both strategic organizational aspects and technical requirements specific to blockchain technology. These factors encapsulate the challenges, resources, and support systems necessary for blockchain to function effectively within a supply chain context. By identifying and validating these factors, this study aims to provide a foundational understanding that can guide both practitioners and researchers in navigating blockchain implementation in supply chains. This analysis delves into the factors as described below.

- The Decentralized Governance factor ensures effective coordination and decision making among distributed stakeholders in a blockchain network. It emphasizes the importance of collaboration, transparency, and regulatory compliance without relying on a central authority.
- Decentralized System Vitality addresses the ongoing health and performance of blockchain systems.
- Decentralized Security and Encryption focus on safeguarding technology against threats.

- Strategic Leadership focuses on how leadership drives the strategic direction and supports blockchain initiatives.
- Organizational Strategy assesses how blockchain aligns with broader business goals.
- Future Readiness examines the adaptability of blockchain solutions to future needs.
- Infrastructure Readiness evaluates the technical preparedness to support blockchain.
- Supportive Ecosystem explores the environment that enhances blockchain adoption.
- Training and Education emphasize the role of effective training programs in facilitating user proficiency.
- Change Management looks at strategies for managing transitions associated with blockchain adoption.
- User Acceptance investigates how users interact with and accept technology.
- Data Management Practices highlight the importance of handling and protecting data effectively.

Each factor is analyzed to understand its influence on the successful implementation of blockchain technology in supply chains, providing a comprehensive overview of the key elements necessary for effective user adoption and organizational integration.

After identifying the 12 strategic factors influencing blockchain implementation, the next step in our analysis involved examining the relationships and interactions among these factors to uncover broader themes. While each factor independently contributes to blockchain implementation, a closer analysis revealed that certain factors are interconnected and collectively address core dimensions of organizational readiness, technological preparedness, and strategic alignment. By grouping these factors into overarching themes, we gain a more comprehensive understanding of the conditions necessary for successful blockchain implementation. These themes encapsulate multifaceted dynamics among the factors, providing actionable insights into the holistic requirements for implementing blockchain technology effectively within a supply chain context.

### *4.2. Thematic Insights of the Strategic Factors*

Strategic Alignment and Leadership Commitment

This theme encompasses the need for cohesive alignment between blockchain initiatives and organizational strategy, driven by strong leadership support. Factors such as Strategic Leadership, Organizational Strategy, and Future Readiness are central to this theme, emphasizing that successful blockchain implementation requires more than just technical capabilities—it needs to be championed by leaders who can align it with the organization's long-term vision. Leaders play a pivotal role in prioritizing blockchain projects, securing necessary resources, and cultivating a forward-looking approach that prepares the organization to adapt to future technological advancements. This theme highlights that, without a clear strategic alignment and committed leadership, blockchain initiatives may face resource constraints, lack organizational buy-in, and struggle to achieve their full potential. In essence, strategic alignment and leadership commitment form the foundation upon which other factors build, setting the stage for successful blockchain integration within an organization's broader goals.

Organizational Adaptability and Resilience

Blockchain implementation requires a flexible, resilient organization that can manage change effectively and adapt to evolving technological demands. This theme integrates Change Management, Supportive Ecosystem, Training and Education, and Future Readiness. These factors collectively address the organization's capacity to prepare, educate, and adapt its workforce and processes for blockchain integration. Organizational adaptability ensures that all levels of the organization—from leadership to operational staff—are prepared for the changes blockchain introduces, fostering a culture that is open to innovation

and capable of evolving alongside technological developments. Resilience is also reinforced by creating a supportive ecosystem, involving partnerships and collaborations that facilitate the transition to blockchain. By investing in continuous learning and maintaining readiness for future shifts, organizations can sustain blockchain adoption even amid industry changes, further embedding resilience into their core operations.

Data Security and Integrity

For blockchain to function effectively, it must ensure secure and reliable management of data, which forms the backbone of a decentralized system. This theme is built upon factors such as Decentralized Security and Encryption, Data Management Practices, and Infrastructure Readiness. The theme underscores the importance of robust security protocols and data integrity practices, essential for protecting sensitive supply chain information across decentralized networks. Blockchain's distributed nature makes it critical to secure data on every node while maintaining transparency and traceability, which are often key drivers for blockchain adoption. Additionally, infrastructure readiness ensures that the organization's technical environment can handle blockchain's rigorous security demands, supporting a tamper-proof and resilient data system. Data security and integrity are thus not just technological requirements but pivotal enablers of trust, which is fundamental to blockchain's value proposition in supply chains.

User Preparedness and Engagement

Effective blockchain implementation depends on user acceptance and engagement, as they are the direct operators and beneficiaries of the technology. This theme encompasses Training and Education, User Acceptance, and Change Management, emphasizing the role of a well-prepared workforce in facilitating successful adoption. Training and education equip users with the necessary skills and knowledge to interact with blockchain systems, addressing concerns or misconceptions and building confidence in using the technology. User acceptance is equally important; employees who understand the benefits and practical applications of blockchain are more likely to embrace it, reducing resistance to change. This theme highlights that engaging users and preparing them for blockchain use is a crucial step, as even the most advanced blockchain systems require active and informed participation from end-users to unlock their full value.

Decentralized Coordination and Sustainability

This theme addresses the ongoing need for coordinated governance and sustainability in a decentralized environment. It brings together factors such as Decentralized Governance, Decentralized System Vitality, and Supportive Ecosystem to emphasize the importance of a well-maintained, efficient, and sustainable decentralized network. Effective decentralized governance enables stakeholders to participate in decision-making processes, facilitating collaboration and ensuring the system operates smoothly. Meanwhile, decentralized system vitality focuses on maintaining the health of the blockchain, ensuring it can handle increasing volumes of data and transactions over time. By fostering a supportive ecosystem with strong decentralized coordination, organizations can achieve sustainable blockchain operations that remain adaptable to changes in both the technological landscape and industry demands. This theme highlights that blockchain's success relies not only on technical robustness but also on governance structures that support long-term, decentralized management and stakeholder alignment.

Table 2 presents the key themes that emerged from the selective coding process, along with their corresponding strategic factors. Each theme captures the interconnectedness of various factors, presenting a comprehensive view of the conditions necessary for successful blockchain implementation. Together, these themes offer actionable insights that can guide organizations as they address both strategic and operational challenges in adopting blockchain technology.

**Table 2.** Mapping of Strategic Factors to Thematic Categories.

| Theme | Corresponding Strategic Factors |
| --- | --- |
| Strategic Alignment and Leadership Commitment | Strategic Leadership, Organizational Strategy, Future Readiness |
| Organizational Adaptability and Resilience | Change Management, Supportive Ecosystem, Training and Education, Future Readiness |
| Data Security and Integrity | Decentralized Security and Encryption, Data Management Practices, and Infrastructure Readiness |
| User Preparedness and Engagement | Training and Education, User Acceptance, Change Management |
| Decentralized Coordination and Sustainability | Decentralized Governance, Decentralized System Vitality, Supportive Ecosystem |

## 5. Discussion

### *5.1. Contribution to Research*

This study contributes to the growing body of knowledge on blockchain technology (BCT) by offering an in-depth analysis of the strategic factors that influence its successful implementation in supply chain management. While existing research often explores the strategic advantages of blockchain's technical aspects, this study emphasizes the organizational, strategic, and human-centric dimensions critical to BCT implementation in the supply chain domain, thus broadening the understanding of blockchain beyond its technological scope. By identifying and analyzing 12 strategic factors derived from qualitative insights, this research adds depth to our comprehension of the challenges and enablers that affect blockchain implementation in supply chain systems. Additionally, this study's thematic approach provides a structured framework for understanding how these factors coalesce into broader themes, such as strategic alignment, organizational resilience, and data integrity. These themes offer a new theoretical lens for examining blockchain within complex organizational systems, paving the way for future research that can build on these foundational themes to investigate blockchain's role in enhancing transparency, traceability, and collaboration in supply chains. The study advances the integration of grounded theory in blockchain research, offering a methodological contribution that encourages the use of qualitative approaches in examining the nuanced dynamics of emerging technologies.

### *5.2. Contribution to Practice*

In practical terms, this study offers valuable insights for supply chain managers, technology officers, and organizational leaders considering or currently implementing blockchain technology. By identifying 12 critical factors that impact blockchain implementation, this research provides a comprehensive framework that organizations can use to navigate the complexities of blockchain systems and leverage their benefits. For instance, recognizing the importance of Decentralized System Vitality allows organizations to focus on building robust and resilient blockchain networks capable of handling distributed operations, ensuring seamless functionality without reliance on central control. Similarly, Decentralized Governance highlights the necessity of establishing transparent decision-making processes that empower diverse stakeholders to collaborate effectively while maintaining trust and accountability.

Additionally, the role of Decentralized Security and Encryption is crucial, as it ensures data integrity and protection across distributed nodes, reducing vulnerabilities and safeguarding sensitive information. Beyond these, understanding Strategic Leadership and

Organizational Strategy enables companies to align blockchain initiatives with broader organizational goals and ensure leadership buy-in for effective implementation. Practical guidance on User Acceptance and Training and Education further supports organizations in fostering user engagement and easing the transition to blockchain systems, minimizing resistance and enhancing operational efficiency.

The study emphasizes the decentralized aspects of blockchain, which provide organizations with unique advantages not fully realized in traditional systems. Key among the findings is the importance of Decentralized System Vitality and Decentralized Governance. Decentralized Governance plays a critical role in fostering collaboration across diverse actors within the supply chain. This reduces dependency on intermediaries, increasing trust and efficiency. This shift allows for improved data transparency, faster decision-making, and stronger relationships between supply chain partners, ultimately driving both innovation and sustainability.

Additionally, the study highlights the role of Decentralized Security and Encryption in protecting data integrity and preventing breaches. By decentralizing security measures, blockchain technology reduces single points of failure and enhances resilience across the supply chain, providing a more robust defense against cyber threats and ensuring that sensitive information remains secure. Incorporating these decentralized elements into blockchain implementation strategies offers a unique pathway to not only streamline operations but also build resilient, transparent, and secure supply chain ecosystems. These findings provide practitioners with actionable steps to align blockchain technology with the evolving needs of the digital supply chain, driving long-term benefits in operational efficiency.

## 6. Limitation

Despite the contributions of this research, several limitations should be acknowledged. First, the study relied on a qualitative approach using semi-structured interviews, which, while effective for generating in-depth insights, limits the generalizability of findings to a broader population. The perspectives captured reflect the experiences of a selected group of experts and practitioners and therefore may not represent all possible viewpoints across industries or geographies.

Second, although rigorous measures were employed to ensure reliability and validity, the subjective nature of qualitative coding introduces potential researcher bias in data interpretation. Future studies could strengthen the robustness of findings by incorporating inter-coder reliability checks or triangulation with additional data sources such as surveys, case studies, or archival documents.

Third, the study focused on identifying factors influencing blockchain implementation in supply chain management without examining longitudinal outcomes. As blockchain adoption is still evolving, future research would benefit from longitudinal studies to capture how these factors play out over time and across implementation stages.

Finally, while the study identifies twelve key factors, their applicability may vary across organizational contexts. Industry-specific, cultural, and regulatory conditions may shape blockchain adoption differently, suggesting that further empirical testing in diverse settings is necessary to refine and validate the relevance of these factors.

## 7. Future Research

Future research could investigate the relative significance of the 12 strategic factors in blockchain implementation across different industries using advanced methodologies like multi-criteria decision analysis (MCDA) or structural equation modeling (SEM). Comparative studies could examine the varying impacts of factors such as Strategic Leadership,

Decentralized Governance, and Infrastructure Readiness in industries like manufacturing, healthcare, and financial services. This could provide actionable insights for industry practitioners to prioritize resources and tailor implementation strategies effectively. The research could delve into how blockchain-enabled systems enhance decision-making processes within supply chains, such as improving demand forecasting accuracy, optimizing inventory management, and ensuring compliance with sustainability regulations. These studies would emphasize blockchain's potential to transform decision-making from reactive to proactive, supported by real-time, immutable data.

Expanding beyond blockchain's immediate domain, future studies could explore its integration with technologies like quantum computing, edge computing, and digital twins. For instance, quantum-enhanced cryptography could address scalability and security challenges in blockchain networks, while edge computing might enable faster and localized blockchain transactions, critical for time-sensitive supply chain operations. Similarly, digital twins combined with blockchain could offer unparalleled visibility and traceability by creating virtual replicas of physical supply chain systems, fostering predictive analytics and scenario testing. These interdisciplinary explorations could reveal how blockchain interacts with and amplifies the capabilities of other cutting-edge technologies, providing innovative frameworks for building resilient, adaptive, and highly efficient supply chains. Such endeavors would extend the understanding of blockchain's role within a broader technology ecosystem, offering practical solutions for complex global challenges in supply chain management.

## 8. Conclusions

This study set out to address the following research question: what are the key factors that collectively influence the implementation of blockchain technology in the supply chain? Using a grounded theory approach and thematic analysis of expert interviews, twelve factors were identified that shape blockchain implementation across strategic, organizational, and decentralized dimensions.

By answering the research question, this study highlights the interplay of strategic leadership, infrastructure readiness, governance, user acceptance, and other critical elements that collectively determine the success or failure of blockchain adoption in supply chain contexts. These findings contribute to the existing body of knowledge by moving beyond general discussions of blockchain potential and offering empirically grounded insights into the specific conditions that enable effective implementation.

Practically, the identified factors provide guidance for managers and practitioners as they plan, design, and execute blockchain initiatives, helping align organizational readiness with the unique demands of decentralized technologies. While exploratory in nature, the study establishes a foundation for further research to test, validate, and refine these factors across industries and contexts.

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