

Review of Barriers to Implement Blockchain Technologies in Logistics

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Abstract

The benefits of blockchain technologies in logistics are improved transparency, enhanced security, and improved operational efficiency. Constraints to its diffusion in logistics settings have to be put under systematic scrutiny. This paper attempts to identify and classify the main barriers that impede the diffusion of blockchain in logistics. A total of 28 peer-reviewed studies were analyzed, selected using defined inclusion criteria for the period between 2018 and 2023. Thematic analysis included categorizing barriers into technological, organizational, and environmental factors. The results show that a deficiency in technological infrastructure and high costs of implementation are the major identified barriers. Other significant challenges have been identified include lack of government regulation, lack of technical expertise, and data security. Consequently, strategic investments in the removal of such barriers will call for myriad policy interventions. Perception of these barriers will thus facilitate stakeholders in ensuring smooth integration of blockchain technologies within the logistics industry.

CCS Concepts

• Insert your first CCS term here; • Insert your second CCS term here; • Insert your third CCS term here;

Keywords

Blockchain, Logistics, Adoption Barriers, Technological Infrastructure, Implementation Costs

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1 Introduction

The concept of blockchain is representative of evolutionary innovation that is likely to affect the logistics industry soon, ensuring data management in a secure, transparent, and proficient manner. This gives considerable interest in the advantages of supply chain

management, inventory tracking, and process automation (Biswas and Gupta 2019). Despite such promising benefits, the adoption of blockchain in logistics remains exceptionally limited due to several barriers including poor infrastructure, high implementation costs, and a lack of general awareness in many instances (Tangsakul and Sureeyatanapas 2024).

There are various obstacles to the widespread implementation of blockchain technology in the logistics sector. Technical challenges are among the most prominent obstacles. The complex structure of blockchain introduces difficulties related to data security, processing speed, and scalability (Batta et al. 2021). Integrating blockchain with existing system architecture, considering the vast number of touchpoints and intricacy around supply chain processes, has usually been a challenge for logistics companies to accomplish. Viewing this as time-consuming and expensive, many will therefore hinder broad-scale adoption.

From an economic perspective, the initial investments required for the implementation of blockchain technology can be quite high. For small and medium-sized logistics businesses, these investment costs can be a major deterrent to adopting the technology (Munir et al. 2022). In addition, after integrating the technology, operating costs and the sustainability of the technological infrastructure can also be an additional burden for companies.

Legal regulations also stand out as an important barrier. The fact that national and international legal norms regulating the use of blockchain technology have not yet been fully established causes logistics companies to have reservations about using this technology. Issues such as data privacy, validity of smart contracts and compliance with international trade law make it difficult for the technology to be widely used in logistics processes (Cumming et al. 2019).

At the organizational level, the integration of blockchain technology may require radical changes in business culture and business processes. Companies must invest in training and development processes to adapt their employees to this new technology (Kottler 2018). However, this process can be time-consuming and, especially in large organizations, the adoption of blockchain technology may encounter internal resistance (Rejeb et al. 2021).

All these factors combined show that there are serious barriers to the implementation of blockchain technology in the logistics sector. However, overcoming these challenges can provide great benefits in terms of increased efficiency and security improvements in the sector. In this paper, we will focus on identifying the current barriers to the application of blockchain technology in the logistics sector and offering solutions on how to overcome these barriers. There are various barriers for companies operating in the logistics sector to effectively use the potential advantages of blockchain

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technology. The key goal of this research was to investigate, in a structured manner, the major technical, economic, legal, and organizational challenges that impede the adoption of blockchain technology in logistics, as well as identify strategic steps toward its overcoming. Therefore, this research undertakes the task of filling the lacuna in existing studies with valued insights that will facilitate the pervasive and effective integration of blockchain technology into logistics. Finally, this study attempts to find following research question:

What are the main technical, economic, legal, and organizational barriers to the diffusion of blockchain technology in the logistics sector, and what strategic measures may be adopted with a view to overcoming these barriers for wider and more effective use?

2 Literature Review

There are various studies on the barriers to the application of Blockchain in the logistics sector. The literature review examination has made in Web of Science and Scopus data basis by using the “blockchain”, “barrier”, “logistics” key words. Batta et al., (2021) have implemented the use of high-quality data and its optimization for the application of blockchain technology in the logistics sector. Kottler (2018) highlighted the importance of the lack of industry-wide standards for blockchain technology, stressing that without standardization for the interoperability of different blockchain systems, efficiency will decrease. Bjerkenes and Haddara (2020) identified several challenges associated with integrating blockchain technologies into supply chains. This paper focused primarily on the benefits of blockchain and then discussed the barriers, including technological complexity, high implementation costs, lack of standardization, resistance to change among stakeholders, and concerns about data privacy and security. Francisconi (2017) did not specifically address the barriers to implementing blockchain technologies in logistics in his study, providing a study of the challenges faced by companies in determining the real benefits of blockchain for the sector and the potential threat to existing port information systems such as Portbase method. Rejeb et al., (2021) stated in their study that the lack of skilled professionals who understand both blockchain technology and its application in logistics will be a significant barrier to integrated applications in these two areas. Meiklejohn (Meiklejohn 2018) published research focusing on the technical complexities of blockchain, particularly the need for scalable and secure ledger solutions to meet various application requirements. Lopez et al., (2019) conducted a comprehensive study on the regulatory challenges posed by blockchain technology. Their research examined how the novelty of blockchain creates hesitation among regulators due to the potential disruption of traditional economic systems. This paper highlighted the concerns regulators have regarding the risks posed by new, unregulated participants entering the market. Sampathkumar (2022) explored the challenges of integrating blockchain technology with existing logistics systems, such as IoT and cloud-based platforms. This research highlighted the fundamental differences between centralized systems like IoT and cloud technologies and blockchain’s decentralized architecture. The study analyzed how these structural incompatibilities create obstacles for seamless integration. Reja et al., (2022) investigated the complexities of navigating the regulatory landscape for blockchain

technology. Study focused on how blockchain must comply with diverse data protection and privacy laws across different jurisdictions. This study explored the challenges organizations face in aligning decentralized blockchain systems with legal frameworks that are often designed for centralized models. Tan and Zhai (2021) examined the financial barriers to blockchain adoption in the logistics industry, with a focus on small and medium-sized enterprises (SMEs). Their research highlighted how the initial costs of implementing blockchain technology, including infrastructure and integration expenses, can be prohibitive for many logistics companies. They analyzed the financial constraints that prevent SMEs from adopting the technology, despite its long-term benefits.

3 Identifications of Barriers to Blockchain Technologies in Logistics

In the related literature, there are some barriers to using blockchain technologies in supply chain management. These barriers are determined in some papers. They are classified into three sections: technological, organizational, and environmental barriers. Therefore, in this study, we analyzed according to these sections.

Technological Barriers:

Security: Security is a barrier for using the blockchain technologies (Kouhizadeh et al. 2021). Because the data within these technologies is confidential and private, it should never be stolen or lost in any way.

Accessibility: Since who can access these applications and to what extent is a problem, this situation can be considered a barrier to the use of blockchain.

Data immutability: In blockchain technology, the data used is immutable. This means that incorrectly or incompletely entered data cannot be corrected afterward. Therefore, the immutability of data can be considered a barrier.

Infrastructure limitations: Some infrastructure setups need to be established for the use of these applications. These can be cumbersome and expensive, which is why the infrastructure requirement is considered a barrier.

User experience: The complexity of user interfaces or systems can prevent users from adopting these technologies. Therefore, the lack of user experience is seen as a barrier to the use of these technologies.

Organizational Barriers:

Adaption: Due to a lack of standardization, there are challenges in the adoption of blockchain technology in supply chains (Mangla et al. 2021).

Lack of social awareness: It means that blockchain technologies are not sufficiently understood or adopted in society. As a result, some companies may not want to use these technologies. Therefore, this situation is seen as a barrier.

Traditional habits: Traditional habits always serve as a barrier to the use of new technologies.

Environmental Barriers:

Energy consumption: The energy consumption of blockchain technologies is quite high, so the energy consumed for intensive use is seen as a barrier.

Table 1: Related Literature

Authors	Years	Method
Yadav and Kumar	(2022)	Dematel (MCDM)
Biswas and Gupta	(2019)	Dematel (MCDM)
Chavalala et al.	(2024)	İnterpretiçiii.İ.iş.işive structural modeling
Naseem et al.	(2023)	Fuzzy AHP
Nisar et al.	(2024)	Dematel (MCDM)
Khan et al.	(2023)	BWM (MCDM)
Khan et al.	(2023)	Dematel (MCDM)
Boutkhoul et al. 2021	(2021)	IFAHP and Dematel
Kumar and Barua (2023)	(2023)	Hesitant fuzzy set
Okorie et al. 2022	(2022)	Fuzzy AHP
Chaouni Benabdellah et al. 2023	(2023)	AHP and Dematel
Virmani and Singh (2024)	(2024)	Best-Worst Method
Kaur et al. 2024	(2024)	Fuzzy AHP and Fuzzy Dematel
Yadav et al. 2020	(2020)	ISM Dematel
Öztürk and Yıldızbaşı.	(2020)	Fuzzy AHP Fuzzy TOPSIS
Rejep et al. 2022	(2022)	BWM (MCDM)
Kumar et al. 2022		Dematel (MCDM)
Govindan 2022	(2022)	Dematel (MCDM)
Nazam et al. 2022	(2022)	Fuzzy AHP
Patil et al.,	(2023)	Fuzzy BWM
Zkik et al.	(2023)	Pythagorean Fuzzy sets, Cumulative Prospect Theory, and VIKOR
Kouhizadeh et al.	(2021)	Dematel
Wu et al.,	(2023)	Fuzzy Dematel and TOE integrated method
Sahebi et al.	(2020)	BWM
Khan et al.,	(2023)	BWM
Vafadarnikjoo et al.	(2023)	Neutrosophic AHP
Wong et al.,	(2021)	Artificial neural network
Mathivathanan et al.	(2021)	TISM and MICMAC

Regulatory gaps: Due to being new technologies, blockchain technologies may not yet have fully developed legal regulations. Therefore, this situation can be seen as a barrier to their use.

4 Analysis of Studies

We searched the existing literature using the keywords "blockchain" and "barrier," resulting in 28 studies. We analyzed the methods and results of these studies as given in Table 1.

In the literature, the most studied topic regarding barriers to blockchain adoption in logistics is Multi-Criteria Decision Making (MCDM) methods. Generally, these barriers have been analyzed in studies, and the most effective barrier among them has been attempted to be identified using MCDM.

The analysis of the publication years is presented in Figure 1. According to this, 2023 saw the highest number of articles, with a total of 10. In 2024, however, only 4 studies have been found, which is likely due to the fact that publications for 2024 are still ongoing. As can also be seen from the figure, studies on the barrier analysis of blockchain technologies in the logistics field have been increasing year by year.

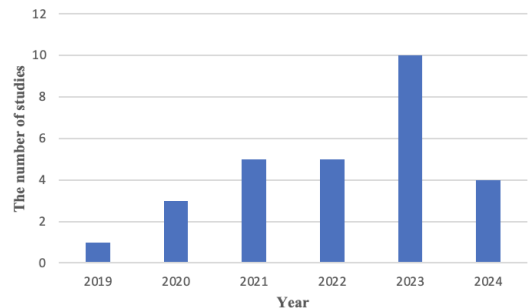


Figure 1: The number of studies by year

When examining the most important criteria found in these studies, it is clear that 'lack of technological infrastructure' emerges as the most significant criterion. Thus, it is evident that "lack of technological infrastructure" is the most significant barrier to the adoption of blockchain technologies across various fields. The implementation of blockchain technologies requires certain specific technological infrastructures. Once these infrastructures are in

place, a compliant transition can occur. However, in the absence of these, the transition will not be effective or appropriate. Consequently, research articles have identified that the most significant issue companies face is the lack of technological infrastructure. Overcoming this barrier requires knowledge, cost, and willingness.

Furthermore, according to the results of the examined articles, the requirement of 'high investment cost' is also one of the second significant barriers. The reason for this barrier is that there are certain requirements for the technological infrastructure necessary for the transition to blockchain technologies. The most important of these is cost. This is because establishing the infrastructures and ensuring compliance involve specific processes, resources, and knowledge, all of which come at a price, thus falling under the category of cost.

Moreover, 'lack of government regulation' has also emerged as one of the most significant barriers. This suggests that companies are awaiting regulatory support from governments for compliance, and they do not feel secure in transitioning without adequate regulations in place. Additionally, in many studies, barriers similar to the 'lack of technical expertise' have been found to be among the most significant. Based on this, parameters such as lack of knowledge and shortage of technical personnel have been identified as barriers and are generally considered the most important. Also, the topic of 'data security' has been identified as a barrier in many studies and mentioned among the most significant barriers in three studies.

According to the analysis, DEMATEL (Decision-Making Trial and Evaluation Laboratory) was used in 13 out of the 28 studies examined. The reason for this is that DEMATEL, as an MCDM method, identifies cause-and-effect relationships, visualizes the interactions among factors, and examines these interactions in depth. This enables a better understanding of the dynamics in complex systems and enhances decision-making processes.

5 Conclusion

This study set out to systematically examine the key barriers hindering the adoption of blockchain technology in the logistics sector. Through a comprehensive literature review of 28 peer-reviewed studies published between 2018 and 2023, we categorized these barriers into technical, economic, legal, and organizational dimensions, providing a nuanced understanding of the multifaceted challenges faced by logistics companies. Full realization of this industry's potential through blockchain technology requires addressing such identified barriers. The logistics sector would gain a lot in terms of benefits accruable from blockchain technology after addressing such challenges as technical, economic, legal, and organizational. Benefits will entail an increase in supply chain transparency, data security, and efficiency in operations with improvement in competitiveness and value addition within the global marketplace. It will require an effective collaboration among the industry players, policy thinkers, and technology developers for the seamless and swift integration of blockchain into the logistics sector.

6 History Dates

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