Blockchain Application in Supply Chain Management

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Abstract

Purpose – This paper provides a brief review of four strands of the literature on blockchain application in supply chain management

Design/methodology/approach – The paper starts with a review of the history of the growth of blockchain technology and its characteristics. Then it examines the key factors and findings of the existing studies on, traceability and transparency, security and counterfeit Prevention, efficiency and cost reduction, and the challenges and limitations respectively. Finally, the conclusion summarizes the article and provides future research directions.

Findings – Although there has been a substantial amount of research conducted to advance our knowledge of blockchain technology, there is still huge potential in the future development of the technology.

Practical implications – Business and technology professionals will find this review informative in enhancing the understanding of blockchain applications in supply chain management.

Originality/value – The paper offers a systematic review of the existing literature, focusing on the overarching theme of the related research findings. This synthesis of information serves to highlight key insights and provides an invaluable resource for future researchers as they build their research programs.

Keywords Blockchain, Distributed ledger technology, Supply chain, Logistics, Traceability, Transparency, Trust, Security, Decentralization, Visibility, Data Integrity

Paper type Literature review

1. Introduction:

In recent years, the advent of blockchain technology has sparked significant interest in various industries, including supply chain management. Blockchain's decentralized and transparent nature has the potential to transform traditional supply chains by enhancing traceability, security, and efficiency. Because of the numerous benefits that blockchain technology provides, according to a report by Allied Market Research, the global blockchain in the supply chain market is expected to reach $9.85 billion by 2025, driven by the need for enhanced risk management and resilience in supply chain operations. As a promising solution for upgrading the supply chain, blockchain technology leverages its decentralized, transparent, and immutable nature and offers innovative development that can revolutionize the way supply chains operate. In light of these facts, this literature review aims to explore the current state of research on blockchain applications in supply chain management, examining its benefits, and challenges. On top of that, we will actively seek to engage in research and discussions relevant to the subject, with the aim of discovering concepts that could serve as effective improvements for blockchain applications in supply chain management.

2. Improved Traceability and Transparency:

One of the key advantages of blockchain in supply chain management is its ability to provide end-to-end traceability. By recording every transaction on the blockchain, stakeholders can track the movement of goods from their origin to the final destination. This feature is particularly crucial for industries like food, pharmaceuticals, and luxury goods, where product authenticity and safety are paramount. Data from Juniper Research indicates that blockchain will generate $31 billion in food fraud savings globally by 2024 by immutably tracking food across the supply chain. Additionally, in 2021 they projected sizable savings in food fraud will be realized and compliance costs will be reduced by 30% by 2024. This demonstrates the large contribution and possible potential of blockchain applications in essential business industries. One of the reasons behind the savings is that blockchain's transparency promotes accountability, as all participants have access to the same information, reducing the risk of fraud or manipulation.

To support blockchain traceability further, this technology ensures that researchers and institutions can securely share and collaborate on data without concerns about its integrity or origin. According to the Chainalysis Crypto Crime 2022 Report, in 2021, illegal activities took part in less than 0.2 percent of all crypto transfers. Although crypto is another aspect of the usage of blockchain, the source can strongly prove blockchain’s ability to trace user origin and prevent fraud. The transparent nature of blockchain also allows stakeholders to have a clear understanding of the data's history and build trust in its accuracy.

In a blockchain-enabled research ecosystem, transparency becomes the cornerstone, fostering trust among researchers, companies, and the wider business community. It eliminates the need to rely solely on trust between parties, as the immutable nature of blockchain records allows for independent verification of research processes and outcomes.

3. Supply Chain Security and Counterfeit Prevention:

Blockchain technology offers robust security measures that can combat counterfeiting and unauthorized modifications in the supply chain. By leveraging cryptographic techniques, blockchain ensures that data remains tamper-proof and authentic. B, Gianmarc et al. (2012) introduce the passive RFID tag, leading-edge public-key cryptography, and offer security mechanisms, which do not need an intact communication infrastructure. Cryptography helps establish secure identity and access management protocols via the development of this type of technology in supply chains. Cryptographic techniques are employed to implement anti-counterfeiting measures within RFID tags that contain cryptographic keys. A. S Kumar et al. (2022) present that these keys can be used to verify the authenticity of products by securely verifying the integrity of the embedded information. This facilitates the detection and prevention of the distribution of counterfeit goods, and it also protects brand reputation and consumer trust.

The decentralized nature of blockchain also reduces the risk of unauthorized access by eliminating single points of failure. Smart contracts, a feature of blockchain, enable automated execution of predefined conditions, such as verifying product authenticity or ensuring compliance with regulations. Xu et al. (2020) state because of the disintermediation of the transactions, smart contracts constitute a significant blockchain application for cost reduction, tracking, visibility, and security enhancement. By “disintermediation”, the terms and conditions of the contract are directly written into the code, automatically and securely specifying the actions or transactions that will be performed when certain conditions are met.

4. Efficiency and Cost Reduction:

The implementation of blockchain technology in supply chain management has the potential to streamline operations and reduce costs. X Tian et al. (2022) indicate that using blockchain technology in cross-border trade and settlement payments reduces the reliance on intermediary agencies. The technology enhances the speed of business processing and improves the efficiency of collaboration across different departments. X Tian et al. (2022) also mention that by eliminating manual processes, paperwork, and intermediaries, blockchain enables faster and more efficient transactions. The decentralized nature of blockchain allows for real-time data sharing, facilitating instant verification and validation of transactions. This can lead to significant time and cost savings for supply chain participants, as well as improved customer satisfaction through faster delivery times and enhanced responsiveness.

5. Challenges and Limitations:

Despite its promising potential, blockchain implementation in supply chain management faces several challenges. Hughes et al. (2019) suggest that databases that are trusted and have distribution capabilities, such as MongoDB and PostgreSQL, encounter issues such as data loss and inconsistencies in reading or writing data and these problems arise from disruptions in the network, power failures, data races, and other factors. The evidence shows that the scalability of

blockchain networks, especially in handling a large number of transactions, remains a significant concern.

Additionally, the research of Hofman, D et al. (2019), raises that ensuring data privacy and compliance with regulations such as GDPR (General Data Protection Regulation) poses challenges in a transparent system like blockchain. One of the fundamental characteristics of blockchain is its immutability, where once data is added to the blockchain, it cannot be easily altered or erased. This poses challenges when it comes to the right to erasure (or right to be forgotten) under GDPR, as individuals have the right to request the deletion of their data.

Moreover, Hellani, H et al. (2021) view that integration with existing legacy systems and industry-wide adoption also present hurdles that need to be addressed for widespread blockchain implementation in supply chains. When the existing systems lack built-in capabilities for blockchain integration, bridging the gap between legacy systems and blockchain technology may involve developing adapters or middleware to facilitate communication and data exchange.

6. Future Prospects and Research Directions:

As blockchain technology continues to evolve, further research is needed to address the current limitations and explore its full potential in supply chain management. Areas of future exploration include developing scalable and interoperable blockchain platforms, ensuring privacy and data protection, integration with emerging technologies, and establishing regulatory frameworks that align with blockchain applications. Additionally, research can focus on real-world case studies and practical implementation strategies to provide insights into the benefits and challenges of blockchain adoption in specific supply chain contexts. Finally, sustainability and energy efficiency have always been a headache for the convenience of blockchain implementation. The energy consumption of blockchain networks, especially proof-of-work-based platforms, is a concern. Research needs to be conducted to develop more energy-efficient consensus mechanisms and explore sustainable blockchain solutions that minimize environmental impact.

7. Conclusion:

This literature review highlights the significant potential of blockchain technology in transforming supply chain management. The use of blockchain offers benefits such as improved traceability, enhanced security, reduced counterfeiting, increased efficiency, and streamlined processes. However, challenges related to scalability, data privacy, integration, and adoption hinder widespread implementation. Continued research and collaboration between academia, industry, and policymakers are crucial to overcome these challenges and fully leverage the transformative power of blockchain in supply chains.

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