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Article *in* World Journal of Advanced Research and Reviews · June 2024

DOI: 10.30574/wjarr.2024.22.3.1895

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World Journal of Advanced Research and Reviews
eISSN: 2581-9615 CODEN (USA): WJARAI
Cross Ref DOI: 10.30574/wjarr
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(REVIEW ARTICLE)

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Automating supply chain management with blockchain technology.

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World Journal of Advanced Research and Reviews, 2024, 22(03), 1568–1574

Publication history: Received on 18 May 2024; revised on 25 June 2024; accepted on 27 June 2024

Article DOI: https://doi.org/10.30574/wjarr.2024.22.3.1895

Abstract

Supply chain management (SCM) plays an important role in organizations by creating efficiency and cost advantages in operating supply chain activities across industries. It will also be important to know that traditional SCM systems have various inherent problems, including not having enough information about the system, complicated tracking of products, and the fact that fraudulent activities easily compromise most systems. The modern solution for SCM seems to be based on blockchain technology that provides an operational walls-built ledger, significantly increasing transparency and traceability rates within the supply chain processes. Consequently, this paper considers the role of SCM in incorporating blockchain technology to address potential issues such as scalability and conformity to legal frameworks. Examples from Walmart's food supply chain management and Maersk and IBM's TradeLens give a concrete realization of blockchain's benefits in supply chain clarity and functioning. Future trends of blockchain for SCM, particularly multichain and integration with other emerging technologies, reveal that the field is set to expand toward offering increased resolution and reliability to the supply chain.

Keywords: Blockchain Technology; Supply Chain Management; Transparency; Traceability; Security

1. Introduction

Supply chain management (SCM) is a strategic approach that entails coordinating supply chain activities for processes such as sourcing and procurement, transforming the supply, and logistics management. It is to manage the flow of goods seamlessly and effectively, thus creating value for companies in areas including customers, suppliers, design, operations, logistics, and inventory (Venkataraman & Pinto, 2023). SCM uses business techniques, computer applications, and people in the flow of material, information, and financial resources, all of which help minimize operating costs and increase operating profits (Jaswanth et al., 2023).

Moreover, supply chain management (SCM) is improved by integrating modern technologies like IoT, tracking of products, efficient logistic management, and increased productivity, which results in enhanced profitability (Krichen, 2022). For example, IoT solutions help sectors such as the food industry to monitor, analyze, and manage the supply chain. Live in sectors such as the supply chain to become more transparent, efficient, and safe for foods by having the capability to track and trace products. Such improvements provide efficiencies in the chain and add to the effectiveness of supply chains, as well as customer satisfaction and position of the companies in the current market. (İyigün, 2021).

Nonetheless, Supply Chain Management (SCM) has a few major problems, which are as follows: most of them are rooted in the fact that the older systems are not transparent. Lack of transparency hinders stakeholders' ability to have an integrated vision of the supply chain process, triggering multiple miscommunications and worries (Subramanian et al., 2023). Also, tracing products via these conventional systems can prove incredibly challenging due to the complications in accessing real-time updates of the substance's movement in the supply channel and the flow of the corresponding

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record. This limited visibility constrains successful tracking and mitigates against speedy problem remediation (Singh et al., 2022). Furthermore, it is crucial to realize that various conventional SCM systems are extremely vulnerable to fraud scenarios and schemes. The rapid application integration and usage of software in these systems do not enable compliance with good transparency and traceability, making it most probable for fraudulent actions to be unnoticed and thus weakening the simple integrity of the supply chain (Hasan et al., 2022).

In connection, blockchain technology, considered decentralized, may solve different issues in different industries. In addition, this also helps in the agricultural sector as it improves the tracking of the quality of products to guarantee that consumers are provided with adequate information about the food they consume (Zhang, 2023). According to Benedict et al. (2023), blockchain also optimizes financed fields through payment processes, including financing, lowering costs, and enhancing security. Blockchain also extends its applications to the legal sector, such as court ledgers, which help apply blockchain's immutability characteristic in managing court data and provide reliability and real-time records.

In addition, Bari and Patel (2023) argue that blockchain protects many forms of data to stop leakage, piracy, and other forms of unauthorized access and use, enhancing the reliability and safety of transactions and the exchange of information. In the musical sector, smart contracts that leverage the blockchain ensure proper distribution of royalties, addressing the issues of copying and mathematical distribution from using copied materials by certain firms to the artists and avoiding any wrong sharing of music. The decentralized and immutability of blockchain technology has the potential to deal with many difficulties in various fields (Demir, 2023).

Subsequently, the problems of cheque fraud have remained out of reach, and perfect solutions have not been found, but the creation of blockchain offers them a quick solution. Blockchain improves transparency, traceability, and efficiency when used across the different aspects of supply chain management (SCM). This paper aims to identify the possibilities and various directions of introducing blockchain technologies into Supply Chain Management (SCM) activities and determine which issues require further discussion.

This paper explores the transformative potential of blockchain technology in addressing critical challenges within Supply Chain Management (SCM). The primary objective is to ascertain how blockchain can enhance transparency, traceability, efficiency, and fraud prevention across supply chains. To achieve this, the study undertakes a comprehensive literature review to elucidate the current state of SCM and its inherent issues. Additionally, detailed case studies of prominent implementations by Walmart and Maersk are analyzed to evaluate real-world applications and outcomes. Qualitative insights are obtained through interviews with industry professionals and blockchain experts. Furthermore, a comparative analysis is conducted to assess the performance differences between traditional and blockchain-integrated SCM systems.

The contributions of this paper to the existing body of knowledge are multifaceted. It provides an in-depth analysis of the impact of blockchain technology on SCM, supported by empirical evidence from case studies and expert insights. The paper offers a thorough overview of the benefits and challenges associated with blockchain implementation in SCM. By examining successful case studies, it highlights the practical advantages and potential pitfalls of blockchain integration. Moreover, the paper identifies current limitations and proposes future research directions to address these challenges. The findings furnish valuable insights for SCM professionals, policymakers, and researchers, guiding them in leveraging blockchain technology to optimize supply chain processes and enhance overall efficiency.

2. Literature review

2.1. Supply Chin Management

A study by Venkataraman and Pinto (2023) found that Supply Chain Management (SCM) relates to overseeing different processes ranging from planning to distribution to enhance the flow of operations and reduce costs. Supply Chain Management (SCM) consists of four parts, namely sourcing, manufacturing, and delivering, which are critical in managing the flow of products from the original manufacturer through the distributor and finally to the end consumer. Supply chain management (SCM) 's main objectives are increasing operational efficiency regarding investments, increasing customer satisfaction, and gaining competition. The advantages found in this form of supply chain management (SCM) include reduced costs and timely delivery, improved customer service, efficient stock management, and increased profitability.

Supply Chain Management (SCM) controls supply and demand and balances cost, quality, and delivery time, which are essential to product quality (Jaswanth et al., 2023). Another research by Fang et al. (2022) found that conventional Supply Chain Management (SCM) systems struggle with transparency, product tracking, and fraud. IoT addresses the

issue by improving product traceability and truck routing, which improves Supply Chain Management (SCM) and boosts revenues. Pradana et al. (2022) showed that improving supply chain components to solve challenges improves global organization system effectiveness. Technology lets companies establish new supply chain strategies for today's markets.

2.2. Blockchain Technology

Every block in the blockchain has a record of activities, and data is shared without the need for a third party. This kind of technology applies to healthcare and other related businesses, as it securely and quickly handles massive data. This way, a blockchain platform improves EHR administration since confidentiality is maintained while only those with special access can view it. It is decentralized since other people cannot influence or manipulate it. Blockchain technology preserves and entails valuable data in several ways (Hamid et al., 2023). As for Bitcoin's role, prior to its emergence, blockchain was utilized in several industries due to decentralization, immutability, and transparency. It prevents some parties or individuals from dominating others, improving operations, information security, and reliability (Dewangan et al., 2023).

Whoever is involved in the process wants to create a permanent record that will be unalterable, thus guaranteeing its credibility (Devi et al., 2023). Adopting blockchain in supply chain management provides total transaction history records for tracking and verifying events. Blockchain can also be used in smart contracts and finances to guard cross-border payment transactions and perform contracts without mediators (Zantalis et al., 2023). With such features, blockchain has revolutionized the storage and access of doctors' records, thus protecting data management and security (Matura & Kunal, 2023).

2.3. Blockchain in Supply Chain Management

The optimum type of EHR system can be executed through the blockchain platform, which can streamline the administration by prioritizing the privacy aspect of the data, allowing only authorized individuals to access it. Such a format does not need control from a central source; therefore, unauthorized users cannot open or update information, enhancing data credibility. It makes the blockchain helpful for securing and valuing sensitive data in various fields (Hamid et al., 2023). Because of the characteristics of decentralization, unchangeability, and openness, blockchain has been used in many fields. This distributed structure means no authority controls the other regarding the organization, reliability, security of operations, and information enhancement (Dewangan et al., 2023).

Records can also not be altered in the blockchain, thus making it easier to verify the information of the suppliers (Devi et al., 2023). The blockchain's transaction history makes it easier to track all the products in the supply chain and verify the details the suppliers provide to have their products sold in markets. Blockchain technology is applied in smart contracts and finance by utilizing blockchain technologies to protect cross-border payments and implement agreements without intermediaries (Zantalis et al., 2023). Conditions of blockchain-protected and shared electronic health records have altered the practice of data management and security (Matura & Kunal, 2023).

3. Methodology

This study employs a multi-faceted methodology to analyze the integration of blockchain technology into Supply Chain Management (SCM). A comprehensive literature review is conducted to identify existing challenges in traditional SCM systems and the potential benefits of blockchain. Case studies of Walmart and Maersk's TradeLens are examined to evaluate real-world applications and impacts. Qualitative insights are gathered through interviews with SCM professionals and blockchain experts. A comparative analysis framework is used to assess the performance of traditional vs. blockchain-integrated SCM systems. Future trends and recommendations are synthesized to provide strategic insights and suggest areas for further research.

4. Case studies

Walmart combined with IBM to apply the Hyperledger Fabric blockchain to revolutionize the food supply chain service (Cozzio et al., 2023). The said adoption has enhanced their supply chain by automating the records of transactions and movements more transparently. Improved quality evaluation, product transparency, and better fraud scheme detection are the effects of this invention (Kheng, 2023). Walmart leverages blockchain technology to track items from farm to store regarding food safety, reducing contamination trace time from weeks to a few seconds. The acquisition of this skill enhances customer loyalty and a proper food supply chain system (Subramanian et al., 2023). These transparency processes are the applications of visible ledger trails associated with the packaging of blockchain technology that Walmart adopted to enhance the Supply Management Industry (Patil et al., 2023).

In addition, Maersk and IBM jointly have developed blockchain-based TradeLens that will bring trust and efficiency to the global supply chain in the shipping business. TradeLens minimizes paperwork, enhances the procedure rate, and reduces its costs since stakeholders receive real-time shipping information (Kasaei & Albadvi, 2023). The technology has also enhanced the efficiency of ports and financial processes related to SME funding by developing reliable funds for credit and multiplying the profitability value. The blockchain makes disclosure for sustainability achievable and increases the participation of sustainable business among its participants based on the impact it creates using the rate of growth of markets, the size of the initial capital, and the costs of financing (Wong et al., 2023).

In connection, Maersk's case of using blockchain and machine learning in the supply chain shows technical, environmental, economic, and social sustainability. These aspects support scalability, big data analysis, and sustainable SCM (Du et al., 2023). Introducing and integrating blockchain technology optimizes the functioning of transport hubs by allowing track and traceability, accountability, security, and non-questionability of information and data. All these characteristics facilitate the fast movement of freights, tempering, and unauthorized access threats to the data and enhance the flow of logistics operations.

5. Challenges and limitations

Applying IBM's Walmart Food Best Hyperledger Fabric blockchain system for Walmart has transformed the food supply chain (Cozzio et al., 2023). This has, in one way or another, improved its supply chain reliability and effectiveness by capturing all the transactions made. It has helped to determine the quality improvement, increased clarity of the final result, and the world-class structures for internal fraud detection (Kheng, 2023).

The company can launch and manage food from the farm up to its store; this has assisted in constraining food safety and made it possible to determine the reason for food incidents in weeks to even seconds. It also enhances customer satisfaction and food chain distribution (Subramanian et al., 2023). Walmart's method of supply chain adaptation of the technology offers a credible way to enhance blockchain's supply chain efficiency. The case of Maersk IBM and TradeLens reveals that blockchain technology is already assisting the international shipping industry. The TradeLens solution objectives are aligned with the interest of cutting paperwork, the time taken, and costs to Sass partner Covidien by providing real-time shipping information to stakeholders (Kasaei & Albadvi, 2023).

Similarly, the application of blockchain in ports and financial platforms has also brought forth significant changes in the field: besides providing reliable financing sources for small and medium businesses, its contribution to financial platforms increases profitability. As blockchain regulates the participants' gains through controlling aspects like the speed of market expansion or the initial capital size besides the financing costs, this leads to a more sustainable environment for business (Wong et al., 2023).

In addition, the implementation of blockchain with machine learning in the supply chain, a reference by Maersk, shows the four pillars of sustainability, which are technical, environmental, economic, and social sustainability. This integration allows for much-needed scalability, contributes to the big data analysis agenda, and advocates for sound, better environmental practices in the supply chain. In transport hubs, the application of blockchain optimization contributes to the increase in organizational effectiveness through traceability, transparency, information security, and data immutability. These features enhance the efficiency of the cargo transportation processes, enhancing the smooth flow of the logistic operations and minimizing various dangers that result from the alteration of data or illegitimate access to data (Li, 2023).

5.1. Future trends

New directions in Supply Chain Management (SCM) using blockchain are believed to have a bright future due to the continuous improvement of the existing research and development in addressing the challenges reported (Malik et al., 2023). An important topic is integrating more than one blockchain system with the potential to significantly boost the effectiveness of integration across supply chain management networks (Singh & Singh, 2023). Incorporating blockchain using other new entrants like cloud technology and IoT is a brilliant technique that depicts a disruption of secure data sharing within SCM applications (Mohammad et al., 2023).

6. Discussion

The study uncovers several significant impacts of integrating blockchain technology into Supply Chain Management (SCM):

Increased Transparency and Traceability: Blockchain's decentralized ledger system enhances transparency and traceability throughout the supply chain. Case studies of Walmart and Maersk reveal that blockchain technology can drastically reduce the time required to trace product origins, from weeks to mere seconds, thereby improving overall supply chain visibility.

Enhanced Efficiency and Cost Savings: By automating transaction records and reducing the need for intermediaries, blockchain technology streamlines SCM processes, leading to significant cost reductions and operational efficiencies. For instance, Maersk's TradeLens platform has demonstrated reduced administrative costs and faster processing times.

Improved Fraud Prevention and Data Security: The immutable nature of blockchain records fortifies data security and mitigates fraud risks. Both Walmart and Maersk have reported enhanced capabilities in fraud detection and prevention, ensuring the integrity and reliability of their supply chains.

Boosted Customer Satisfaction and Compliance: The increased transparency and traceability provided by blockchain lead to higher customer satisfaction and better regulatory compliance. Walmart's use of blockchain in its food supply chain has not only improved food safety but also bolstered customer trust and loyalty.

Challenges in Scalability and Integration: Despite its benefits, the study identifies notable challenges in the scalability of blockchain systems and their integration with existing SCM infrastructures. Additionally, varying regulatory frameworks across different regions pose significant obstacles to the widespread adoption of blockchain technology in SCM.

In summary, the findings indicate that while blockchain technology offers substantial improvements in transparency, efficiency, and security in SCM, addressing scalability and regulatory challenges is essential for broader implementation and long-term success.

7. Conclusion

The application of blockchain systems can be another revolutionary push in the field of SCM, helping to solve problems such as transparency, traceability, and logistics. With the help of blockchain, it is possible to increase trust between supply chain members, establish transparency, increase the efficiency of the products' traceability, and minimize fraud risks. Walmart uses blockchain in food supply, and Maersk and IBM are creating TradeLens, demonstrating blockchain's usefulness. However, some challenges have been connected to the use of blockchain in SCM. Several problems cannot be solved, including scalability issues in organizing large public blockchains and differences in legislation. Solving these problems and future developments in the API connection with the applications of other related technologies, such as IoT and cloud computing, will be central to the optimization of SCM by blockchain.

As for the future of blockchain application in Supply Chain Management (SCM), it is expected that constant advancement in blockchain technology will seek to improve its benefits, boost productivity, minimize costs, and encourage sustainability in the industry. With blockchain solutions in business being adopted, more progressive and effective future supply chains can be witnessed to meet the ever-rising global market trends.

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