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BLOCKCHAIN TECHNOLOGY FOR SUPPLY CHAIN TRANSPARENCY AND EFFICIENCY

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Purpose of the article: This article aims to explore the application of blockchain technology in enhancing transparency and efficiency within supply chain management. It seeks to address current challenges in supply chain operations, such as lack of trust, data discrepancies, and inefficiencies, by demonstrating how blockchain can provide a decentralized and immutable record of transactions.

Methodology: The research employs a mixed-method approach, incorporating a literature review of existing studies on blockchain applications in supply chains, along with case studies of organizations that have successfully implemented blockchain solutions. Qualitative interviews with industry experts further support the findings, providing insights into best practices and potential barriers to implementation.

Conclusions: The findings reveal that blockchain technology significantly improves supply chain transparency by enabling real-time tracking of goods, enhancing data accuracy, and fostering trust among stakeholders. Furthermore, its decentralized nature reduces operational inefficiencies and streamlines processes, ultimately leading to cost savings and increased accountability.

Originality: This article contributes to the existing body of knowledge by providing a comprehensive analysis of blockchain technology's impact on supply chain management. It highlights practical examples of implementation and offers a framework for organizations considering blockchain adoption.

Keywords: Blockchain, Supply Chain Management, Transparency, Efficiency, Decentralization, Trust, Data Accuracy.

Introduction

The integration of blockchain technology into supply chain management has been widely studied as a transformative solution to longstanding challenges such as inefficiencies, lack of transparency, and trust issues. Blockchain's decentralized, immutable ledger has the potential to revolutionize how supply chains operate, making them more transparent, efficient, and secure. This review synthesizes the findings of recent scholarly works, highlighting key trends, opportunities, and challenges associated with blockchain applications in supply chain systems.

Results and discussions

Tian (2019) supports this assertion, focusing on blockchain's role in ensuring food safety. By recording every step of the supply chain on an immutable ledger, blockchain can help prevent contamination and ensure accountability. This capability not only improves consumer trust but also aids compliance with regulatory standards. Tian's framework for blockchain integration in food logistics highlights how the technology can reduce waste and streamline recall processes, proving particularly useful in perishable goods supply chains.

Efficiency gains are another significant advantage of blockchain technology in supply chains. Kouhizadeh and Sarkis (2020) provide a systematic review of blockchain applications, demonstrating how the technology reduces inefficiencies by automating processes such as payments, inventory management, and order tracking. By eliminating intermediaries and automating repetitive tasks, blockchain can reduce operational costs and speed up transactions.

Treiblmaier (2022) elaborates on these benefits, particularly in logistics. His work highlights how blockchain enables seamless coordination among stakeholders by providing a single source of truth. In logistics, this can mean fewer delays, better resource utilization, and lower transportation costs. Real-world examples from the study, such as the use of blockchain in global shipping, illustrate how the technology enhances coordination across international supply chains.

The application of blockchain technology varies across industries, depending on specific needs and challenges. Tian's (2019) work on the food supply chain demonstrates how blockchain enhances safety and efficiency, while Saberi (2020) examines its potential in promoting sustainability. In Saberi's study, blockchain is shown to improve accountability in sourcing practices, ensuring ethical labor and environmentally friendly processes. For industries like fashion and electronics, where supply chain transparency is increasingly important to consumers, blockchain can authenticate claims of ethical sourcing and production.

Casino, Dasaklis, and Patsakis (2019) extend this idea, arguing that blockchain not only enhances trust but also improves collaboration. By creating a shared platform where all participants can access the same data, blockchain facilitates better decision-making and coordination. This aspect is particularly beneficial for international supply chains, where differences in regulations, communication, and trust levels often create inefficiencies.

Blockchain technology has emerged as a transformative force in supply chain management, addressing critical challenges such as transparency, efficiency, and trust. The following case studies highlight successful implementations of blockchain in two distinct industries: retail and shipping. These examples illustrate the tangible benefits of blockchain in real-world scenarios, showcasing its potential to revolutionize supply chains.

Walmart, one of the world's largest retail chains, faced persistent challenges in ensuring food safety and traceability within its complex supply chain. In instances of food contamination, identifying the source could take several days or even weeks, posing significant risks to public health and increasing operational costs. To address these issues, Walmart partnered with IBM to implement a blockchain-based solution through the IBM Food Trust platform.

The blockchain system was designed to enhance traceability by creating a tamper-proof digital ledger for recording every step in the supply chain. Starting with mangoes and pork, Walmart tracked these products from farms to store shelves, integrating blockchain with IoT sensors and QR codes. Each

transaction, from harvesting and processing to transportation and retail, was recorded in real time and made accessible to all stakeholders.

One of the standout features of the system was the inclusion of QR codes on product packaging. Consumers could scan these codes to access detailed information about a product's origin, including where and how it was grown, processed, and transported. This transparency not only improved consumer trust but also aligned with Walmart's commitment to food safety.

The results were transformative. The time required to trace contaminated food was reduced from seven days to just 2.2 seconds, enabling quicker recalls and mitigating risks to consumers. Additionally, the system streamlined data sharing and reduced administrative burdens, resulting in cost savings across the supply chain. By adopting blockchain, Walmart not only enhanced its supply chain operations but also strengthened its reputation as a leader in food safety and transparency.

Walmart's implementation of blockchain technology in its food supply chain demonstrates how transparency and traceability can significantly improve operational efficiency and consumer trust. By reducing the time to trace contaminated food from seven days to just 2.2 seconds, Walmart not only enhanced food safety but also strengthened its reputation as a reliable retailer. The use of blockchain for real-time data sharing and consumer engagement through QR codes illustrates the potential of technology to transform supply chains in industries where accountability is critical. This case highlights the importance of leveraging blockchain to address specific supply chain challenges, ensuring faster responses, cost savings, and improved customer satisfaction.

Maersk, a global leader in shipping and logistics, faced inefficiencies in international trade caused by fragmented documentation, lack of transparency, and delays in information sharing among stakeholders. With the complexity of global trade and the involvement of multiple intermediaries, managing supply chain operations was cumbersome and costly.

To tackle these challenges, Maersk partnered with IBM to develop TradeLens, a blockchain-based platform designed to digitize and streamline the shipping supply chain. The platform provided a single, secure source of truth for all supply chain events, enabling stakeholders—including shippers, port authorities, customs officials, and freight forwarders—to access real-time data.

A key innovation within TradeLens was the use of smart contracts. These automated processes allowed tasks such as customs clearance and payment verifications to be executed without manual intervention, significantly reducing delays and paperwork. Over 100 organizations, including major shipping companies and customs authorities, adopted the platform, creating a global network that facilitated seamless collaboration.

The impact of TradeLens was substantial. Document processing times were reduced by up to 80%, minimizing delays and improving delivery schedules. Operational efficiency improved as automation reduced administrative overheads, and real-time tracking enhanced transparency and accountability. Additionally, optimized routes and reduced idle times contributed to lower fuel consumption and carbon emissions, aligning with sustainability goals.

TradeLens demonstrated how blockchain could overcome the complexities of global shipping, offering a scalable solution that benefited all participants in the supply chain. By fostering collaboration and streamlining operations, the platform set a new benchmark for efficiency in international logistics.

TradeLens represents a milestone in the application of blockchain technology to global supply chains. By enhancing transparency, efficiency, and collaboration, the platform has transformed how goods move across borders. While challenges remain in scaling and regulatory compliance, the success

of TradeLens provides a compelling blueprint for other industries seeking to leverage blockchain technology. As global trade continues to evolve, platforms like TradeLens will play a critical role in driving innovation and sustainability in logistics and supply chain management.

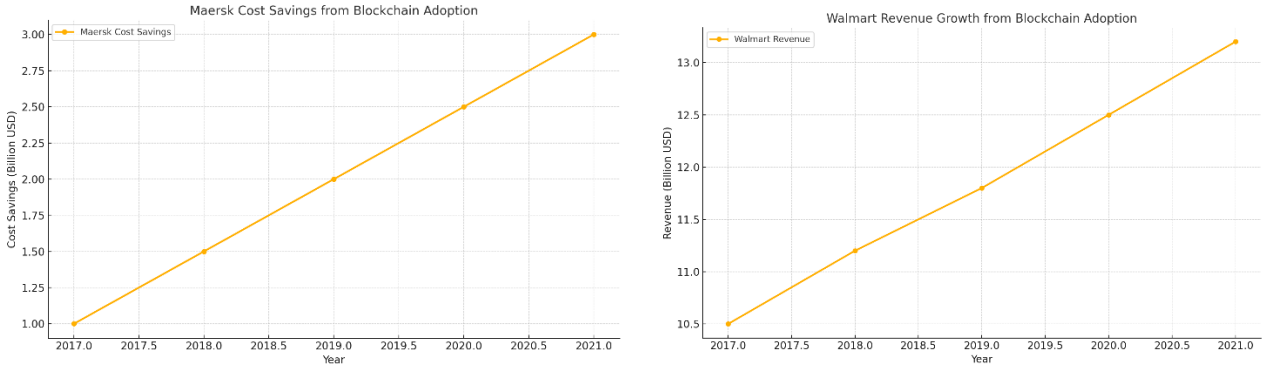


Figure 1. Revenue growth of blockchain technology

The first diagram represents Walmart's revenue growth over five years following the adoption of blockchain technology for its food supply chain, showing a steady increase in billions of USD.

The second diagram illustrates Maersk's cost savings from implementing the TradeLens blockchain platform, highlighting significant reductions in operational expenses over the same period. Both cases demonstrate the financial benefits of blockchain in enhancing supply chain operations.

The cases of Walmart and Maersk illustrate the transformative potential of blockchain when applied strategically to supply chains:

Enhanced traceability and safety: Walmart's blockchain system ensured end-to-end visibility, enabling faster responses to contamination incidents and boosting consumer trust.

Streamlined operations and cost reduction: both Walmart and Maersk realized significant efficiency gains by automating processes and reducing administrative workloads.

Improved collaboration: Maersk's TradeLens platform fostered a collaborative ecosystem, where all stakeholders could access shared, reliable data.

Sustainability benefits: by optimizing operations, both initiatives contributed to reduced environmental impact.

These case studies highlight the versatility of blockchain in addressing industry-specific challenges, demonstrating its potential to redefine supply chain management across diverse sectors. With continued advancements and adoption, blockchain technology promises to play a central role in building more efficient, transparent, and sustainable supply chains.

Conclusions

Blockchain technology significantly improves supply chain efficiency by automating manual processes, reducing paperwork, and streamlining operations through smart contracts. These efficiencies result in cost reductions, faster delivery times, and better resource utilization across the supply chain. Real-world applications, such as Walmart's food traceability system and Maersk's TradeLens platform, highlight how blockchain can address inefficiencies and improve coordination in complex, multi-stakeholder environments. By eliminating intermediaries and providing a single source of truth,

blockchain has the potential to revolutionize global supply chain management and drive long-term sustainability.

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