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Blockchain and Supply Chain Management: The Future of Trust and Transparency

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Abstract: ***Supply chain management involves the coordination of various parties in the production, handling, and distribution of goods. Blockchain technology offers a new approach to managing the supply chain by enabling the creation of secure, decentralized, and transparent networks for tracking and verifying the movement of goods. This can help improve supply chain efficiency, reduce the risk of fraud and counterfeiting, and provide greater visibility and traceability throughout the entire supply chain. With its ability to facilitate real-time tracking, smart contracts, and secure data sharing, blockchain technology has the potential to revolutionize the way supply chains are managed.***
Keywords: Supply chain management, Blockchain, Decentralized, Transparency, Security

I. INTRODUCTION

Blockchain is a type of distributed ledger technology that creates a secure, decentralized record of transactions. It is a digital, tamper-evident record of transactions that is shared among multiple parties. Each transaction is recorded on a "block" and added to a chain of previous transactions, forming a permanent, unchangeable record. There are several problems in supply chain management that could potentially be addressed by using blockchain technology.

One such problem is a lack of transparency and traceability. In a traditional supply chain, it can be difficult to track and verify the history and movement of goods, making it difficult to ensure the accuracy and integrity of the supply chain. With a blockchain-based system, every step in the supply chain can be recorded and verified, providing a clear and unchangeable record of a product's history. Another common problem in supply chain management is the risk of fraud and tampering. In a traditional supply chain, it can be difficult to detect and prevent fraudulent activities such as counterfeiting or the introduction of fake or substandard goods. The decentralized and secure nature of blockchain technology can help to prevent tampering or fraud, and can make it easier to detect and address any potential issues.

Additionally, the use of blockchain technology can help to improve the efficiency and cost-effectiveness of supply chain operations. By enabling direct, peer-to-peer transactions, blockchain technology can help to streamline supply chain processes and reduce the need for third-party intermediaries.

This can help to reduce costs and improve the overall efficiency of the supply chain. Overall, the use of blockchain in supply chain management has the potential to address many of the common problems and challenges faced by supply chain managers, and can help to improve the transparency, security, and efficiency of supply chain operations.

II. MOTIVATION

Blockchain is a type of distributed ledger technology that is characterized by its immutability. This means that once information is recorded on a blockchain, it cannot be altered or deleted. This is achieved through the use of cryptographic techniques and a decentralized network of participants who must collectively agree on any changes to the ledger. In the context of supply chain management, the immutability of blockchain technology can be leveraged to provide a tamper-proof record of the movement of goods throughout the supply chain.

This can help prevent fraudulent activities such as the mislabelling of products or the tampering with product certifications. It can also provide a verifiable audit trail that can be used to improve transparency and traceability in the supply chain. Additionally, the decentralized nature of blockchain networks can enable greater collaboration and information sharing among supply chain participants, without the need for a central authority or intermediary.

This can help improve supply chain efficiency and coordination, and reduce the risk of costly disruptions or delays. Overall, the use of blockchain technology in supply chain management has the potential to enhance security, transparency, and efficiency throughout the entire supply chain.

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III. RELATED WORK

1) *U. Agarwal et al., "Blockchain Technology for Secure Supply Chain Management: A Comprehensive Review," in IEEE Access, vol. 10, pp. 85493-85517, 2022, doi: 10.1109/ACCESS.2022.3194319.*

The current state of application of BC and Smart Contracts in a variety of important industrial fields. The survey provides academically solid data on the current condition of BC adoption throughout diverse supply chains. The study's findings and conclusions suggest that research on BC-based supply chains is a hot issue that is gaining traction.

The majority of the studies studied and analysed agreed on the potential benefits that BC may provide to the supply chain. Furthermore, the challenges, opportunities, and future perspectives of employing BC in the supply chain are fully addressed in order to highlight open research issues on genuinely implementing BC in the future. A lack of in-depth grasp of BC technology may undermine its benefits. We believe that our research provides scholars, engineers, educators, and general readers with a thorough understanding of BC's theoretical discoveries. It also outlines future research objectives in areas combining future technology.

2) *M. Hader, a. Elmhamedi and a. Abouabdellah, "blockchain technology in supply chain management and loyalty programs: toward blockchain implementation in retail market," 2020 ieee 13th international colloquium of logistics and supply chain management (logistiqua), 2020, pp. 1-6, doi: 10.1109/logistiqua49782.2020.9353879.*

The evolution of blockchain and its application in supply chain businesses or loyalty programs is presented, which enables the creation of shared, secure, decentralized ledgers, smart contracts, and reduces the use of intermediaries, lowering the cost of transactions and operations in supply chain or loyalty programs.

This article discusses the obstacles that businesses face while using blockchain technology, in addition to providing an overview of blockchain technology and its many applications in the retail industry. Companies in the retail industry will begin to seize opportunities provided by blockchain technology in order to achieve greater transparency, more efficient supply chain management, and reliable loyalty programs for customers, thereby leading retailers to cost savings and increased customer satisfaction. There are significant chances for better knowledge and application to transcend standard information systems, which encourages us as academics to suggest and investigate propositions in the retail business. Understanding the full implications of blockchain technology in the retail business necessitates transdisciplinary implications as well as the participation of organizations in developing standards and guidelines for blockchain deployment. There is undoubtedly a large amount of work in this area for future study direction.

3) *S. Yousuf and D. Svetinovic, "Blockchain Technology in Supply Chain Management: Preliminary Study," 2019 Sixth International Conference on Internet of Things: Systems, Management and Security (IOTSMS), 2019, pp. 537-538, doi: 10.1109/IOT SMS48152.2019.8939222.*

The appropriateness of blockchain in terms of improved trust and decentralization in the following supply chain stages: order fulfilment, supplier relationship management, production flow management, and demand management The report focused on the primary four of the eight SCM phases since they were the most investigated in the literature in terms of the challenges faced in achieving efficient supply chain performance. Each level of the supply chain was examined in the literature for difficulties that would cater to the requirement for trust and decentralisation components in order to qualify for blockchain implementation, resulting in the suggested framework.

4) S. *Saberi, M. Kouhizadeh and J. Sarkis, "Blockchains and the Supply Chain: Findings from a Broad Study of Practitioners," in IEEE Engineering Management Review, vol. 47, no. 3, pp. 95-103, 1 thirdquarter, Sept. 2019, doi: 10.1109/EMR.2019.2928264*

Blockchain technology is a new and potentially game-changing supply chain technology. We discovered that there are many motives, but also impediments, to its implementation in the supply chain. Because of the novelty of the technology, it is a dangerous undertaking, particularly given the lack of expertise and comprehension. Many businesses are still attempting to separate the hype from genuine skills and promises. We have offered a glimpse here, but we anticipate that these concerns will swiftly evolve as the industry begins to better understand the challenges at hand. In future reports and articles, we plan to include updates as well as more extensive analyses and linkages. For the time being, we'd want to provide some preliminary data to assist firms in benchmarking their position against a larger industry set of viewpoints. Because blockchain adoption is still in its early stages, we want to perform the same study in a few years to explore the progress of blockchain implementation in the supply chain.

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IV. SYSTEM ARCHITECTURE

The system architecture for a supply chain management system using blockchain technology would likely involve the integration of blockchain-based solutions with existing supply chain management processes and systems. At a high level, the architecture could involve the creation of a decentralized network of participants who are involved in the supply chain, such as manufacturers, suppliers, transportation providers, and retail outlets. Each participant would have access to a shared, distributed ledger that is maintained on the blockchain. The ledger would contain information about the movement of goods throughout the supply chain, including details such as the location, quantity, and quality of goods. This information would be securely recorded on the blockchain using cryptographic techniques, ensuring that it is tamper-proof and verifiable. The system would also include mechanisms for tracking and verifying the movement of goods throughout the supply chain in real-time, using technologies such as RFID (radio-frequency identification) and IoT (Internet of Things) sensors. This would enable supply chain participants to monitor the progress of goods in near real-time, providing greater visibility and traceability. In addition, the system could incorporate the use of smart contracts, which are self-executing agreements with the terms of the contract encoded into the blockchain. This could enable the automatic and transparent execution of supply chain-related contracts, reducing the need for manual intervention and improving efficiency. Overall, the system architecture for a supply chain management system using blockchain technology would involve the integration of blockchain technology with existing supply chain processes and systems, enabling the creation of secure, decentralized, and transparent networks for tracking and verifying the movement of goods. Furthermore, we can improve the efficiency and comfort by adding in QR codes and RFIDs to the product.

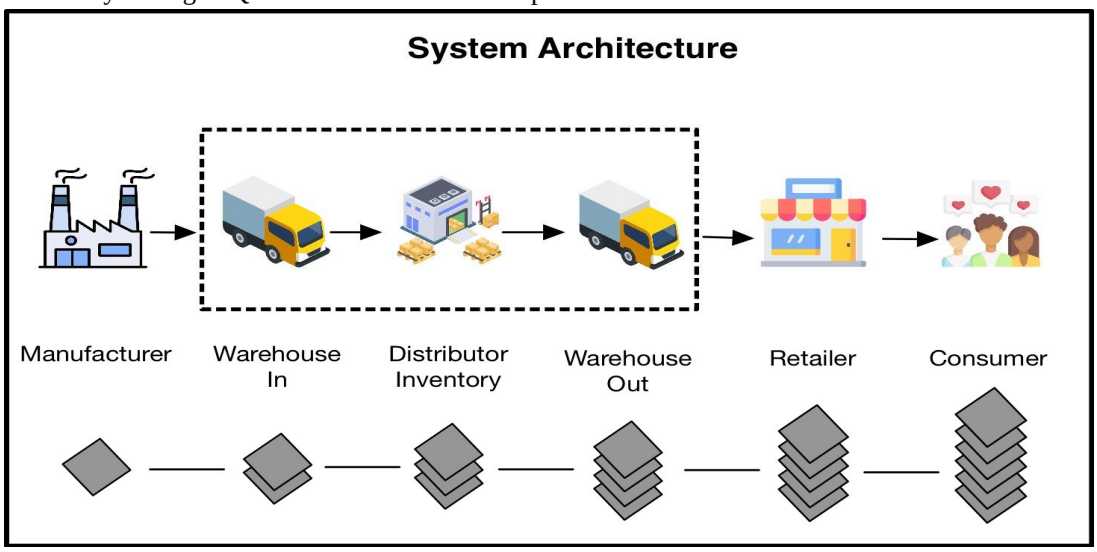


Fig. 1 System Architecture

In an SCM using blockchain technology, users could utilize a range of technologies to share information across the supply chain. These could include technologies previously discussed such as QR codes, NFC (near-field communication), and RFID (radio-frequency identification) tags. QR codes, which are two-dimensional barcodes that can be scanned using a smartphone or other device, could be used to provide quick and easy access to information about a product or shipment. For example, a QR code could be placed on a product label or packaging, and when scanned by a supply chain participant, it could provide information such as the product's origin, destination, and other relevant details. NFC, which is a short-range wireless technology that enables the communication between devices, could be used to facilitate the exchange of information between supply chain participants. For example, an NFC-enabled device such as a smartphone could be used to read and write information to an NFC tag attached to a product or shipment. This could provide a convenient and secure way to access and share information about the movement of goods throughout the supply chain. RFID, which uses radio waves to identify and track objects, could be used to automatically track the movement of goods throughout the supply chain. RFID tags, which are small, wireless devices that can be attached to products or shipments, could be used to transmit information about the location, quantity, and quality of goods in real-time. This could provide greater visibility and traceability, and help prevent fraud and counterfeiting. Overall, the use of technologies such as QR codes, NFC, and RFID in a supply chain management system using blockchain technology could provide a convenient and secure way to share and access information about the movement of goods throughout the supply chain.

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In a supply chain management system using blockchain technology and QR codes, communication between the various parties involved in the production, handling, and distribution of goods could be facilitated through the use of a single product ID that is embedded in the QR code.

For example, a manufacturer could create a unique product ID for each product that it produces. This ID could be encoded into a QR code and placed on the product label or packaging. When a retailer receives the product, they could scan the QR code using a smartphone or other device, which would provide access to the product's ID and associated information.

The retailer could then use the product ID to access information about the product's origin, destination, and other relevant details, which would be securely recorded on the blockchain. This information could be shared with other supply chain participants, such as distributors and consumers, through the use of the product ID and QR code.

In this way, the use of a single product ID that is embedded in a QR code could facilitate communication and information sharing among the various parties involved in the supply chain, enabling greater collaboration and coordination. This could help improve supply chain efficiency, reduce the risk of fraud and counterfeiting, and provide greater visibility and traceability throughout the entire supply chain.

V. FUTURE SCOPE

It is feasible to document transactions in an eternal distributed record using blockchain technology, and to oversee transactions more securely and openly. This also aids in reducing human mistakes and time delays. It is also used to track expenses, employment, and product releases at each stage of the supply chain Additionally, by tracking things back to their source, the decentralised ledger may be used to determine whether they are legitimate or fair trade goods. This can help in various forms such as: -

A. Payments to Automotive Suppliers

Because transactions are done directly between payer and payee, blockchain enables the movement of monies anywhere in the globe without the need for traditional banking operations.

B. Cold Chain Management

Food and medicinal items frequently require specific storage. Furthermore, businesses see the advantage in sharing warehouses and distribution centers rather than paying for their own.

C. RFID-enabled Contract Bidding and Execution

RFID tags are routinely employed in the supply chain to store product information. IT systems can automatically read the tags and process them.

VI. CONCLUSION

To conclude, a decentralized network made possible using blockchain will have numerous advantages for a supply chain network. The blockchain will make all aspects of the supply chain interconnected, making the data more secure, traceable, and structured. This will positively impact all stakeholders involved including customers, manufacturers, and delivery services.

Additionally, a decentralized supply chain network using blockchain technology can improve transparency and accountability within the supply chain, as well as enhance efficiency and reduce the potential for fraud. This can ultimately lead to cost savings for businesses and improved customer satisfaction. The use of smart contracts on the blockchain can also automate many supply chain processes, reducing the need for manual intervention and the potential for errors. Overall, the implementation of a decentralized supply chain network using blockchain technology has the potential to greatly improve the efficiency and effectiveness of the supply chain.

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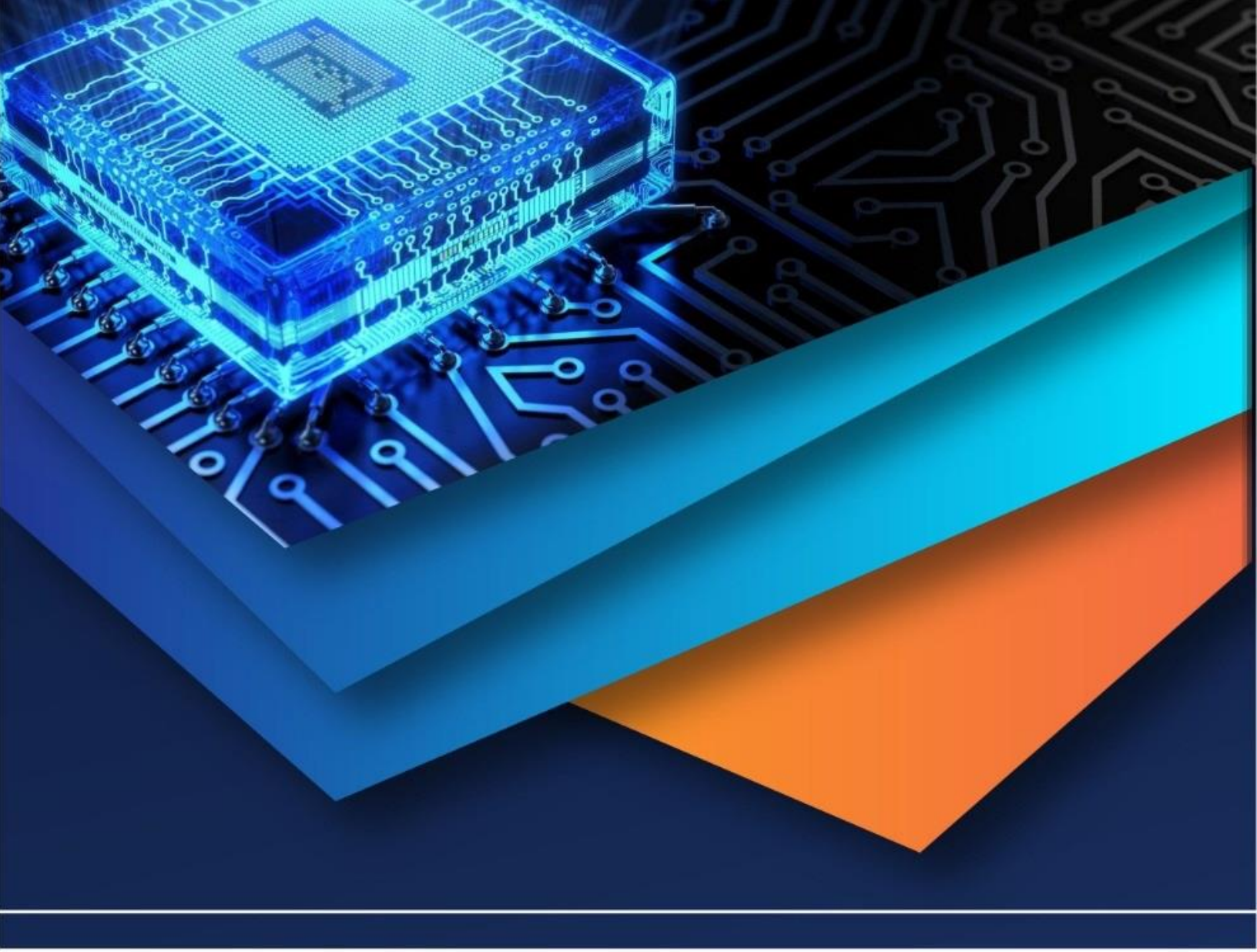
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