

# Analysis on the improvement of Supply Chain Management using Blockchain.

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**Abstract**—In order to ensure openness, traceability, and efficiency throughout all of its activities, the supply chain sector is experiencing growing complexity and problems. The expanding needs of contemporary global trade frequently provide a challenge for traditional supply chain management methods. This abstract investigates how blockchain technology offers a workable remedy to revamp supply chain management and get over its fundamental drawbacks. A distributed ledger technology called blockchain makes it possible to store and handle data in a safe, decentralised manner. Supply chain participants may build a visible, unchangeable, and tamper-proof record of each transaction and movement of commodities using blockchain technology. All parties, including producers, suppliers, distributors, retailers, and customers, benefit from the increased data visibility. Improving efficiency, transparency, and security throughout the whole supply chain offers enormous potential when blockchain technology is integrated into supply chain management. Businesses should anticipate significant gains from simplifying their processes and staying ahead in a globally competitive market as technology continues to advance and become more widely used. However, overcoming technology obstacles, addressing standardisation problems, and encouraging collaboration among supply chain stakeholders are necessary for effective deployment.

## I. INTRODUCTION

The supply chain is made up of a complex web of partners, including suppliers, manufacturers, distributors, retailers, and customers.[1] Controlling the supply chain has historically been challenging due to issues including lack of transparency, fragmented data, counterfeiting, inefficient processes, and participant confidence. However, blockchain technology, was primarily developed for cryptocurrencies like Bitcoin, offers a viable strategy for addressing these challenges. This thesis examines the application of blockchain technology in supply chain management with a focus on the benefits and implications for various industries. Analysis of blockchain's potential for transparency and traceability, its effects on efficiency and funding, and its potential to revolutionise supply chain management fostering cooperation and trust, analysing scalability and interoperability issues.

preparedness, and researching actual use cases.

Insights and tactics for utilising blockchain technology to alter supply chain management practises will become increasingly relevant if these aims are met. The study also intends to highlight possible hazards and security concerns, outline important advantages and disadvantages of using blockchain to supply chains, and look at the social and environmental effects of blockchain adoption. Supply chain management (SCM) is a crucial procedure used in a variety of businesses and sectors where products are produced, distributed, and delivered. In order to maintain a seamless and effective flow of goods from suppliers to manufacturers, distributors, retailers, and finally to end customers, operations must be coordinated and optimised. SCM is a crucial component of contemporary corporate operations because it gives businesses the ability to efficiently manage their supply chain networks, cut costs, raise customer satisfaction, and gain a competitive advantage. Retailers often rely on supply chain management to control inventory levels, monitor sales and avoid stockouts

## II. USE CASES OF BLOCKCHAIN IN SCM

1. Food tracking and safety: In the food sector, blockchain technology may be used to trace food goods from the farm to the consumer's plate. Consumers may scan a QR code on the packaging to obtain details about the food's origin, agricultural methods, and any inspections or certifications it has passed thanks to the blockchain's ability to track every stage of the supply chain. This improves food safety and enables shoppers to make wise decisions.

2. Blockchain may be used to maintain the integrity and authenticity of pharmaceutical items across the supply chain, according to the pharmaceutical supply chain[6]. It makes it possible to follow the flow of pharmaceuticals from the producer to the pharmacy, lowering the danger of fake drugs and guaranteeing that drugs are carried and maintained correctly to keep their efficacy.

3. **Luxury Goods Authentication:** In the market for luxury goods, blockchain may be used to confirm the provenance of pricey items like jewellery, watches, and handbags. The blockchain may store a unique digital certificate for each luxury item, enabling buyers and sellers to quickly confirm its provenance and validity.

4. **Real-time tracking of shipments of cargo and goods** is possible with blockchain in the field of logistics. The blockchain can automatically update the position, state, and temperature of products in transit by integrating IoT (Internet of Things) sensors, improving visibility and lowering the possibility of theft or damage.[2]

1. **TRANSPARENCY:** By offering a decentralised, immutable

5. **Management of certifications and Compliance:** Blockchain

can automate the management of certifications and compliance in supply chains. It can monitor certifications like Fair Trade, origin, the location of the item, and how it was handled. This Organic, or ISO standards to make sure that suppliers and goods adhere to the necessary requirements

6. **Customs and cross-border commerce:** Blockchain can help authenticity, assuring legal compliance, cutting down on with cross-border trade by offering a safe and effective platform for stakeholders to share customs declarations and trade-related documentation. As a result, less paperwork will be generated, less delays will occur at customs, and global trade will run more smoothly.

Blockchain-based smart contracts can automate payments in supply networks. Smart Contracts for Automated Payments. For instance, the smart contract might automatically release payment to the supplier upon the fulfilment of specific preset conditions (such as the delivery of items and the verification of their quality), expediting the payment process and minimising delays.

record that is available to all players, blockchain technology improves supply chain management transparency. Each transaction on a blockchain is logged on several nodes, and a consensus is achieved to authenticate and certify the transaction's legitimacy. Stakeholders may view the movement of items, the status of orders, and the flow of information across the supply chain in real time thanks to this openness.[7] Organisations may enhance efficiency and lower risks by making better decisions, identifying bottlenecks, and taking timely action when they have access to accurate and trustworthy information.

2. **TRACEABILITY:** The capacity of blockchain technology to offer end-to-end supply chain traceability is one of its main benefits. An immutable record is created for each transaction on

the blockchain that contains information about the place of

open audit trail may be used to track and confirm product

counterfeiting, and boosting customer confidence. Blockchain-based traceability may be used to more effectively identify and manage problems with safety, quality control, and



.III. EXPLORING THE EFFECTS AND APPLICATIONS OF TECHNOLOGY OF BLOCKCHAIN recalls in sectors including food and medicines.

3. **SECURITY:** Supply chain management benefits from increased security thanks to blockchain technology's decentralised and cryptographic properties. Because the blockchain uses sophisticated cryptographic methods to encrypt transactions, it is very difficult for hackers to change or manipulate the data. Additionally, because the blockchain is dispersed, there is no single point of failure, making it less

vulnerable to hackers.[3] Organisations may create a safe and contract enforcement, payment settlement, and regulatory impenetrable system that defends against fraud, preserves compliance. Transactions are accelerated through automation, sensitive data, and reduces the risk of data breaches by which also reduces mistakes, disagreements, and delays for integrating blockchain technology. smoother operations and increased production.

**EFFICIENCY:** Blockchain technology has the ability to boost efficiency overall and streamline supply chain procedures. Blockchain's decentralised structure eliminates the need for middlemen, cutting the time and expense of conventional paper-based operations. Furthermore, smart contracts, which are self-executing agreements written in blockchain code, automate processes related to the supply chain, including dedication to sustainability and satisfy security may be difficult. growing customer

demand for products that are both socially and ecologically made more difficult by the absence of standardised protocols and responsible. Additionally, blockchain-based solutions can make data formats between traditional systems and blockchain it easier to adopt circular economy principles including platforms.[5] Multiple stakeholders must frequently work monitoring and controlling the lifespan of items, encouraging together and cooperate to achieve seamless integration, which recycling and reuse, and reducing waste production. can be difficult to arrange.



#### .IV. CHALLENGES AND IMPLICATIONS

1. Scalability is one of the main issues that blockchain supply chain management is now experiencing. Due to the high throughput needed for seamless and effective supply chain operations, the current state of blockchain infrastructure may not be able to support the multiple transactions and interactions that are involved in supply chains amongst various parties. Consensus techniques used by public blockchains like Bitcoin and Ethereum, such proof-of-work, have limitations that might cause transaction speeds to lag and fees to spike at busy times. Private or permissioned blockchains have higher scalability, but to handle the rising number of transactions, they need to be carefully designed and planned.

#### 2. Integrating with Older Systems:

The supply chain sector has traditionally operated and managed data using old legacy technologies. It can be difficult and expensive to integrate these old systems with blockchain technology, necessitating a considerable overhaul of current workflows and procedures. The integration procedure may be

3. Data Privacy and Security: Although the inherent security aspects of blockchain are commended, maintaining data privacy within the context of supply chain management can be a challenging task. Since all data is visible to all users on public blockchains, there is a risk of disclosing private information. Although private and permissioned blockchains provide users more control over data access, doing so while maintaining data

4. Standardisation: For blockchain technology to be widely used in supply chain management, interoperability and standardisation are essential. The smooth interchange of data and assets on the blockchain is hampered by the absence of standardised protocols and data formats across many sectors and supply chain ecosystems. To allow transparent and straightforward collaboration among supply chain stakeholders, consensus must be reached on data formats, communication protocols, and smart contract standards. Organisations, industry associations, and regulatory agencies must collaborate to create common standards that support data consistency and interoperability.

5. Cost and Complexity: Using blockchain technology in supply chain management may be an expensive and difficult task from a technological standpoint. Infrastructure, software development, and continuous maintenance all demand large investments. It may be challenging for SMEs to justify the initial investment and continuing costs of adopting blockchain technology. The technological challenges of blockchain also need specialised knowledge, which raises the entire cost. These challenges include maintaining consensus methods, assuring data integrity, and executing smart contracts.

6. Blockchain networks rely on consensus processes for network rule modifications and for determining the legitimacy of transactions. However, reaching a consensus among numerous stakeholders can be a difficult and time-consuming task. Delays in putting upgrades into effect and addressing serious problems can be caused by disagreements over network governance and decision-making. Claret norms and directives that strike a balance between the interests of all parties are necessary for efficient governance in a decentralised and distributed system.

7. Regulation and Legal Compliance: As the regulatory environment surrounding blockchain and cryptocurrencies changes constantly, supply chain participants who want to embrace the technology face difficulties. Particularly for cross-border supply chains, unclear or conflicting legislation in many jurisdictions might complicate legal and compliance issues. To win over regulators and other industry participants' trust and approval, it is crucial to address regulatory issues and make sure that existing rules are being followed.

8. Energy Use: Some blockchain networks, particularly open proof-of-work blockchains like Bitcoin, are criticised for using a lot of energy. Environmental issues arise as a result of the high computational demands of mining or validating transactions on these networks. Businesses must think about the environmental impact of implementing energy-intensive blockchain solutions as sustainability becomes a critical component of supply chain management. It's important to remember, though, that not all blockchains utilise energy-intensive consensus techniques. Some more recent blockchain platforms, such as proof-of-stake or delegated proof-of-stake, are more energy-efficient and may provide options for applications in the supply chain.

#### V. ROLE OF IOT IN ENHANCING BLOCKCHAIN BASED SUPPLY CHAINS

By combining two potent technologies, the Internet of Things (IoT) and blockchain technology, supply chain management may be completely transformed. Supply chains are intricate networks with numerous participants, cross-regional transactions, and processes. Ensuring efficiency, traceability, and transparency throughout the supply chain is the problem. These problems are addressed in different ways by IoT and blockchain, and their cooperation can have a synergistic effect. Real-time data gathering and communication are made possible by Internet of Things devices that include sensors and are

connected to the internet.[4] These gadgets are capable of tracking and keeping an eye on a number of supply-chain variables, including product location, temperature, humidity, and other environmental factors. They offer a steady stream of data, allowing stakeholders to see the situation in real time.

The advantages are increased when IoT and blockchain technologies are combined. The blockchain receives real-time data regarding product movements, temperature changes, quality measurements, and other crucial characteristics from IoT devices, which serve as the data sources. In turn, the blockchain serves as a safe and open platform for archiving this data. Through this integration, the supply chain network's authorised members are guaranteed access to correct, unchangeable data collected from IoT devices.

Traceability is one of the main uses of IoT and blockchain in supply chain management. It is now possible to follow a product from its point of origin to its point of sale through the combination of various technologies. In sectors like food and pharmaceuticals, where safety and compliance are crucial, this level of traceability is priceless. Stakeholders can rapidly pinpoint the cause of any quality problems and take steps.

#### VI. CHALLENGES AND IMPLICATIONS

There are significant difficulties with combining IoT and blockchain in supply chain management include data security and privacy. Ensuring data privacy is crucial because IoT devices acquire sensitive information about product movements, conditions, and other supply chain characteristics. Although the decentralised nature of blockchain offers some security, it is still necessary to put extra encryption and access control measures in place to protect the data and limit access to only authorised parties. Another problem to solve is interoperability. The communication protocols and data formats used by various blockchain platforms and IoT devices may differ. It takes standardised efforts and the creation of interoperable solutions to provide smooth integration and data sharing between these disparate systems.

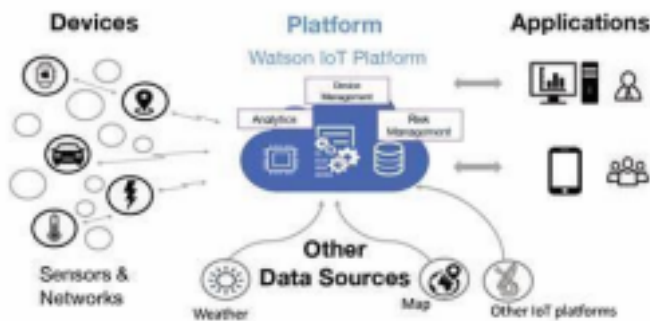
For small and medium-sized businesses (SMEs) in the supply chain ecosystem, adopting IoT devices and blockchain solutions can be expensive. Furthermore, some stakeholders may be deterred from implementing these technologies due to their complexity. Therefore, to encourage wider use, user-friendly and cost-effective solutions are paramount.

When using IoT and blockchain in supply chains, it's imperative to take legal and regulatory concerns into account. The handling of sensitive supply chain data and the deployment of IoT devices must adhere to local



data protection and privacy laws. Likewise, existing legal frameworks must be considered when evaluating smart contracts and automated operations.

Despite these difficulties, incorporating blockchain and IoT into supply chain management has too many potential advantages to be overlooked. A transparent and reliable ecosystem is produced by fusing real-time data from IoT devices with the immutability of the blockchain. This improves the effectiveness of the supply chain, lowers fraud, lowers risks, and promotes stakeholder cooperation.



## VI. CONCLUSION

The incorporation of blockchain and IoT in supply chain management can open up new options for sustainability and environmental impact monitoring in addition to the typical advantages of transparency, traceability, and efficiency. Supply chains can track more than just items and transactions thanks to the use of these technologies; they can also monitor how each step in the supply chain affects the environment. IoT devices can be used to monitor environmental factors including energy use, greenhouse gas emissions, water use, and waste production along the supply chain. A permanent and auditable record of the supply chain's environmental impact is then created using this data and stored on the blockchain.

With this knowledge, supply chain stakeholders may spot inefficiencies and environmental impacts and use that information to support data-driven decisions that will improve procedures and reduce environmental effect. For instance, businesses can identify high-emission transportation routes and look at substitute, environmentally friendly options. Additionally, by improving inventory management, they may collaborate with suppliers to get products in a sustainable manner and cut waste.

Utilizing blockchain for environmental impact monitoring adds another level of credibility and trust to sustainability claims. Stakeholders may trust that the reported environmental indicators are accurate and authentic because the data is safely kept on an immutable ledger. A company that is devoted to sustainability may benefit from increased

consumer, investor, and regulatory body trust as a result of this transparency.

Additionally, the use of blockchain and IoT for sustainability monitoring can use smart contracts and tokenization to encourage moral behavior. Suppliers and partners who exhibit eco-friendly business practices may be rewarded with tokens or digital assets that are valuable inside the ecosystem of the supply chain. On the other hand, failure to satisfy sustainability goals may result in sanctions or privilege loss. The gamification of sustainability fosters healthy competition and propels ongoing development.

In summary, the incorporation of blockchain and IoT in supply chain management not only improves transparency, traceability, and efficiency but also creates new opportunities for environmental impact mitigation and sustainability monitoring. Supply chains may make data-driven decisions, optimise operations, and encourage sustainable practises across the whole supply chain network by utilising real-time data and immutable records on the blockchain. This special feature of the

blockchain and IoT integration has the ability to change supply chains into organizations that are more environmentally and socially conscious, which would be beneficial to the global struggle for a sustainable future.

There are a few challenges and implications that come in between incorporating both technologies to improve SCM. But there are a few solutions to them as well.

- Implementing stringent data quality assurance procedures for IoT devices to guarantee accurate and trustworthy environmental effect data. To quickly find and fix any differences, regular calibration, maintenance, and validation processes should be developed.
- Cybersecurity Measures: Putting data security and privacy first by putting strong cybersecurity measures in place. For the purpose of safeguarding delicate environmental data from unauthorised access and online dangers, this includes robust encryption measures, multi-factor authentication, and frequent security audits.
- Interoperability Standards: Creating and following interoperability standards for blockchain platforms and IoT devices. Encourage the use of open-source products and teamwork to promote seamless data transfer between diverse platforms, making adoption and integration easier.
- Cost-Effectiveness: Looking at low-cost options for integrating blockchain technology and installing IoT devices. To lessen the cost, take into account

cloud-based services, shared infrastructure, and partnerships.

- Solutions for scalability: Investing in research and development to make blockchain networks more scalable. To manage the expanding amount of real-time data produced by IoT devices, investigate solutions like sharding, layer 2 protocols, and off-chain data storage.

- Frameworks for Regulatory Compliance: Staying informed about changing environmental and data privacy legislation and creating frameworks for compliance as necessary. To ensure adherence to standards and best practises, engaging with appropriate authorities and industry organisations.

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