IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

ISO 3297:2007 Certified ⁜ Impact Factor 7.12 ⁜ Vol. 10, Issue 3, March 2023

DOI: 10.17148/IARJSET.2023.10304

Blockchain Technology for Supply Chain and Logistics

Sagar Mal Nitharwal[1], Pragya Chaudhary[2]

Assistant Professor, Computer Science, BTKIT Dwarahat, Almora, India[1]

Assistant Professor, Computer Science, BCE Bakhtiyapur, Patna, India[2]

Abstract: Blockchain technology has the potential to revolutionize the way supply chains and logistics are managed in the manufacturing industry. This technology allows for secure and transparent information sharing across a distributed network of participants, enabling greater visibility and traceability throughout the supply chain. By leveraging blockchain, manufacturers can reduce the risk of counterfeiting, ensure the authenticity of their products, and streamline supply chain operations. With a blockchain-based system, participants can track the movement of goods and materials, verify the origin and quality of products, and ensure compliance with regulations and standards. Additionally, blockchain technology can facilitate faster and more efficient transactions, reducing costs and delays associated with traditional payment and settlement processes. This can help manufacturers to optimize their supply chains, improve inventory management, and enhance customer satisfaction. Despite its potential benefits, implementing blockchain technology in the manufacturing industry can be complex, requiring significant investment in infrastructure, data management, and stakeholder engagement. This paper provides a comprehensive overview of blockchain technology in manufacturing supply chains and logistics and highlights its potential to transform how manufacturing operations are managed and optimized.

Keywords: blockchain; manufacturing supply chain; smart contracts; asset tracking; distributed ledger; Industry 5.0.

I. INTRODUCTION

The manufacturing industry relies heavily on efficient supply chain and logistics operations to ensure the timely delivery of high-quality products to customers. However, the complex nature of these processes often results in challenges such as delays, errors, and high costs. Blockchain technology, with its ability to facilitate secure and transparent sharing of information, has the potential to transform the way manufacturers manage their supply chains and logistics operations. With blockchain, manufacturers can establish a decentralized network of participants, recording each transaction as tamper-proof. This enables greater visibility and traceability throughout the supply chain, helping to reduce the risk of counterfeiting and ensuring the authenticity of products. Additionally, blockchain can streamline payment processing and improve inventory management, enabling manufacturers to optimize their operations and enhance customer satisfaction. The modern supply chain is about managing data, services, and products packaged into solutions. In contrast, the traditional supply chain is all about concentrating on the "where" and "when" of a physical product [3]. Blockchain technology can be extremely helpful in addressing the majority of data-related challenges that a manufacturing supply chain faces, such as the absence of a traceability mechanism for products, identifying counterfeit/grey market products, improving product visibility, and getting rid of paperwork and administrative hassles throughout the product life cycle, even though it is not a magic bullet that can solve all supply chain-related problems. For instance, the market has been overrun with counterfeit goods due to the pandemic-driven surge in demand for medical personal safety equipment like masks and protective gear. To ensure the legitimacy of the goods, VeChain, a blockchain-powered platform, has implemented shipment boxes that carry a VeChain non-fungible token chip and a two-factor authentication QR code [4]. In the modern industrial era, corporations often deal with many small-scale supplier and vendor networks over which they have little control. Global suppliers' lower faith. In low-trust situations, business partners see each other as competitors [1]. To ensure supply chain network success, they must build trust. However, reluctance to share trade secrets and IP, the need to check compliance and regulatory standards and raw material quality, and poor communication cause friction between the manufacturer and supplier. Digitizing all supply chain assets using IoT and linking data-gathering to an immutable decentralized network improves data reliability and asset tracking [2]. Blockchain data is more trustworthy because it cannot be changed and must be verified by all participant nodes. It also helps businesses avoid losses from counterfeit and grey market parts, especially in critical and high-value goods like consumer electronics, jewellery, pharmaceutical, automotive, defence, and aerospace components. A blockchain-integrated supply chain and logistics system offer high security, transparency, traceability, and trust because all transactions are non-editable and timestamped.

IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

ISO 3297:2007 Certified ⁜ Impact Factor 7.12 ⁜ Vol. 10, Issue 3, March 2023

DOI: 10.17148/IARJSET.2023.10304

Blockchain-backed supply chains also benefit from "smart contracts" with vendors and contractors. A blockchain-stored smart contract automatically executes when contractual duties are met [5]. It automates consensus without an intermediary. When requirements are met or milestones are reached, the agreement can start the next step. It resembles a computer language's "condition statement" (if-else or if-then). Smart contracts can verify and perform contracts, track inventory, handle intermediary payments, send notifications, and issue tickets without manual intervention or paperwork in a supply chain.

II. METHODOLOGY

Unlike conventional supply chains, blockchain-based supply chains improve traceability throughout the network by automatically updating the data transaction records whenever a change is made. Contrary to Bitcoin and other financial blockchain applications, which may be public, blockchain-based supply chain networks may require a closed, private, permissioned blockchain with a small number of players. A more flexible collection of partnerships, however, is still possible.

In blockchain-based supply networks, four key actors play roles, including registrars, standard organizations, certifiers, and actors shown in figure 1.

1. Registrars: They provide network actors with distinct identities.
2. Standard organizations develop blockchain rules and technical specifications or standards schemes, such as Fairtrade, for environmentally friendly supply chains.
3. Certifiers: They certify individuals for involvement in supply chain networks.
4. Actors: A registered auditor or certifier must certify participants or actors, such as producers, sellers, and buyers, to retain the system's credibility.

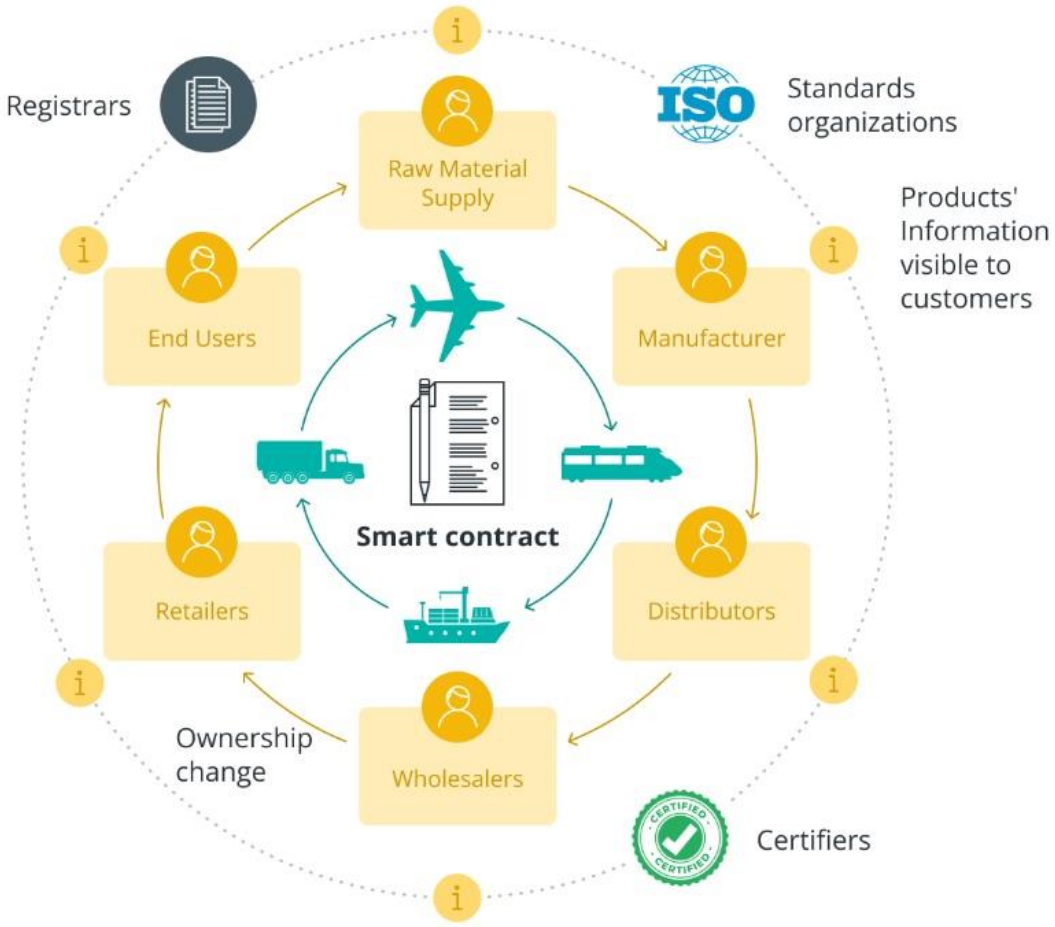

Fig 1: Key Factors in Blockchain-based supply chain

IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

ISO 3297:2007 Certified ⁜ Impact Factor 7.12 ⁜ Vol. 10, Issue 3, March 2023

DOI: 10.17148/IARJSET.2023.10304

The blockchain-based supply chain and logistics process is a complex and multi-stage process involving several key stakeholders and activities. In this section, we will examine each stage in more detail.

1. Product creation and registration: The first stage of the process involves creating and registering a product on the blockchain. This typically involves the manufacturer providing information such as the product type, origin, and specifications. This information is then stored on the blockchain, providing a secure and transparent record of the product's history.
2. Supplier registration: Suppliers who provide materials or components for the product are also registered on the blockchain. This enables manufacturers to verify the authenticity and quality of the materials used in their products and ensure that their suppliers comply with industry standards and regulations. Supplier registration typically involves providing credentials and certification, verified and recorded on the blockchain.
3. Production and quality control: As the product is manufactured, each stage of the production process is recorded on the blockchain. This includes quality control checks and any deviations from standard procedures. By recording this information on the blockchain, manufacturers can ensure that their products meet the required quality standards and that any issues can be identified and addressed promptly.
4. Transportation and logistics: The product is transported to the distribution canter or customer, with each transportation process recorded on the blockchain. This includes information such as the product's location, condition, and delivery time. By recording this information on the blockchain, manufacturers can ensure that their products are delivered in a timely and secure and that any transportation issues can be identified and addressed.
5. Payment and settlement: Payments are settled on the blockchain once the product is delivered. This typically involves smart contracts that automatically release payment based on predefined conditions. Manufacturers can use smart contracts to settle payments promptly and securely without manual intervention or third-party intermediaries.
6. After-sales service: If the customer encounters any issues with the product, they can access the blockchain to verify its authenticity and trace its history. This enables effective after-sales service and can help manufacturers identify and address product issues.
7. Throughout the process, the blockchain provides a secure and transparent record of each transaction, enabling greater visibility and traceability throughout the supply chain. Additionally, blockchain-based systems can enable greater efficiency and automation in supply chain and logistics operations, reducing costs and delays associated with traditional payment and settlement processes. However, it is important to note that implementing blockchain-based supply chain and logistics systems requires significant investment in infrastructure, data management, and stakeholder engagement. Additionally, it may require changes to existing business processes and adopting of new technologies. Despite these challenges, the potential benefits of increased efficiency, transparency, and security make it an attractive solution for manufacturers and other supply chain stakeholders.

III. SUCCESSFUL INDUSTRIAL USE CASES OF BLOCKCHAIN TECHNOLOGY

An exhaustive list of successful industrial use cases from almost all sectors is currently available, demonstrating the extent to which blockchain has transformed businesses. However, only a few of the examples that are in line with the scope of the article are discussed in this section.

The eXtended Compliance End-to-End Distributed (XCEED) blockchain project developed by IBM using IBM Blockchain and Hyperledger Fabric has helped Renault, an automotive manufacturer, to share and overlook compliance standards transparently, accurately, and automatically to the entire supplier network. As an average automotive supply chain deals with hundreds of suppliers worldwide to produce tens and thousands of spare parts that go into various vehicle models, sharing millions of documents related to standards and compliance is cumbersome. The automaker has ascertained that the traditional way of exchanging these files through mail, trading files, and phone calls to the hundreds of suppliers they do business is time-consuming. However, the distributed ledger characteristics of blockchain have enabled them to easily distribute and track data across the entire network while maintaining the confidentiality of the information using a permissioned network [51].

German automaker BMW worked with DHL, a leader in the logistics industry, to develop a blockchain-based proof-of-concept to improve the visibility of parts shipped. A private blockchain network that can show the supply chain-related data to the participants was created to avoid the long manual process. The various access levels ensured that the participants could access only the data that interested them. Additionally, the system’s capability to provide real-time shipment data to their dealers from when an order is placed until it is delivered has helped them reduce manual reports and gave better visibility to real-time data [52].

IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

ISO 3297:2007 Certified ⁜ Impact Factor 7.12 ⁜ Vol. 10, Issue 3, March 2023

DOI: 10.17148/IARJSET.2023.10304

The miles clocked by the automobile odometer is a critical assessment for evaluating vehicles and approving warranty claims. However, the cost of illegal tampering with data is a common threat in the used-car market, the value of which is estimated to be around USD 7.5 billion every year, in Germany alone. To solve the issue, Bosch, an engineering technology company, and TÜV Rhineland, a German certification agency, collaborated to develop a blockchain-based system to prevent data manipulation in the odometer of automobiles. The system collects the distance clocked by the odometer in real-time using IoT sensors, timestamped, and automatically transfers it to a tamperproof blockchain network which ensures the authenticity of the data. The technique can be extended to logistics providers to maintain records of their fleets and assist used vehicle dealers [53].

Maersk, a global shipping company, has collaborated with IBM and developed a blockchain-based trade platform to digitize the supply chain to track end-to-end shipment details. The details related to the progress of goods in the supply chain, the current location of the container, custom clearance documents, bills of lading, and all other relevant data are made visible to all the network participants in a tamperproof database. The platform provides greater visibility to goods-in-transit, eliminates cumbersome paperwork, and improves participant transparency and trust. In addition, it can avoid delays and offers enormous cost benefits [54].

RCS Global, a leader in delivering responsible sourcing of raw materials, has partnered with IBM and developed the Responsible Sourcing Blockchain Network. Originally developed to trace the origin of Li-ion metal used in manufacturing batteries, the technology can support end-to-end tracking of all raw materials from mine to customer. The granular details of the process flow from the time the metal is mined and moved to various stages, such as a smelter, cathode unit, battery unit, and manufacturing plants until it reaches an electric vehicle or a consumer electronic can be traced. This ensures customers that the minerals used in the product are sourced from a responsible sourcing site that is free from conflicts and unethical practices [55]. Here is a table summarizing the statistics on adopting blockchain technology in supply chain and logistics in different significant sectors.

Table: summarizing the statistics on the adoption of blockchain technology in supply chain and logistics

Sector	Technology	Value	Use Case	Key Companies
Food and Beverage	Blockchain, IoT, RFID	Up to $30 million by 2025	Traceability and transparency in the food supply chain	Walmart, Nestle, Dole Food Company, Unilever, IBM
Healthcare	Blockchain, AI	Up to $960 million by 2026	Patient data management and drug supply chain management	Pfizer, Merck, IBM, Change Healthcare, Hashed Health
Automotive	Blockchain, IoT, AI	Up to $1.6 billion by 2026	Supply chain management, tracking and monitoring, vehicle identity verification and recall	BMW, General Motors, Ford, Renault-Nissan-Mitsubishi Alliance, IBM
Retail	Blockchain, IoT, AI	Up to $1.4 billion by 2025	Supply chain transparency, inventory management, and counterfeit prevention	Walmart, Alibaba, Target, JD.com, IBM

IV. CONCLUSION

In conclusion, blockchain technology has the potential to revolutionize supply chain and logistics processes by providing a secure, transparent, and efficient way to track and manage products throughout the supply chain. By enabling end-to-end traceability and provenance, blockchain can help to ensure that products are authentic, safe, and compliant with industry standards and regulations. Additionally, smart contracts and real-time tracking can help streamline logistics and transportation processes, reducing delays and improving customer satisfaction. Furthermore, the involvement of key actors such as registrars, standard organizations, and certifiers can help build trust and confidence in the system, ensuring that all stakeholders can confidently participate in the system. With the potential to reduce costs, improve efficiency, and enhance the overall performance of the supply chain, blockchain technology represents a major opportunity for

IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

ISO 3297:2007 Certified ⁜ Impact Factor 7.12 ⁜ Vol. 10, Issue 3, March 2023

DOI: 10.17148/IARJSET.2023.10304

manufacturers, suppliers, distributors, and retailers alike. However, it is important to note that the adoption of blockchain technology in supply chain and logistics is still in its early stages, and there are a number of challenges that must be overcome in order to realize the full potential of the technology. These challenges include regulatory uncertainty, interoperability issues, and the need for standardized processes and protocols. Nonetheless, the benefits of blockchain technology are clear, and as the technology continues to evolve and mature, it is likely that we will see increasing adoption of blockchain in supply chain and logistics in the years to come.

REFERENCES

[1]. Myers MB, Cheung MS. Sharing global supply chain knowledge. MIT Sloan management review. 2008 Jul 1.
[2]. Khare AA, Mittal A. Blockchain: embedding trust in organic products' supply chain. Journal of Computational and Theoretical Nanoscience. 2019 Oct 1;16(10):4418-24.
[3]. What Is Supply Chain Management? Available online: https://www.ibm.com/in-en/topics/supply-chain-management
[4]. Editor's Desk. Blockchain and Crypto Firm VeChain Utilized to Confirm Authenticity of Coronavirus KN95 Masks. 2020. Available online: https://www.blockchainmagazine.net/blockchain-and-crypto-firm-vechain-utilized-to-confirm-authenticityof-coronavirus-kn95-masks/
[5]. Negi D, Sah A, Rawat S, Choudhury T, Khanna A. Block chain platforms and smart contracts. InBlockchain Applications in IoT Ecosystem 2021 Jun 15 (pp. 65-76). Cham: Springer International Publishing.
[6]. Raja Santhi A, Muthuswamy P. Influence of blockchain technology in manufacturing supply chain and logistics. Logistics. 2022 Feb 8;6(1):15.
[7]. Ledger Insights, DHL, BMW Run Blockchain Trial for Asia Pacific Supply Chain. 2019. Available online: https://www.ledgerinsights.com/dhl-bmw-run-blockchain-trial-for-asia-pacific-supply-chain/.
[8]. Heutger, M.; Kückelhaus, M. Blockchain in Logistics, DHL Customer Solutions & Innovation. 2018. Available online: https://www.dhl.com/content/dam/dhl/global/core/documents/pdf/glo-core-blockchain-trend-report.pdf
[9]. Scott, T. TradeLens: How IBM and Maersk Are Sharing Blockchain to Build a Global Trade Platform. 2018. Available online: https://www.ibm.com/blogs/think/2018/11/tradelens-how-ibm-and-maersk-are-sharing-blockchain-to-build-a-global-trade-platform/
[10].Tucker, M. Sourcing Minerals Responsibly with Blockchain Technology. Available online: https://www.ibm.com/case-studies/rcs-global-blockchain/

