

Blockchain Technology: Transforming Supply Chain Management

Sunit Kumar
 Department of mathematics
 Chandigarh University
 gharuan, India
sunit.e8758@cumail.in

Dr. CS Jyoti Arora
 Chandigarh Group of Colleges,
 Jhanjeri, Mohali, India
csjyotidhillon@gmail.com

Dr Prathap Kumar K,
 Department Of CSE
 Saveetha School Of Engineering
 Simats, Chennai, India.
pradhapkumark.sse@saveetha.com

Mr. Sathish Krishna Anumula,
 Thurkamjal, Hyderabad,
sathishkrishna@gmail.com

Dr S Neelima
 School of Management
 KPR College of Arts Science and
 Research,
 Coimbatore, India
Nelliima1981@gmail.com

Abstract— A significant transformation has arisen in the industry in recent years, with demands and dynamics both increasing, leading to fierce competition. Businesses rely significantly on supply chain functions, which encompass collaboration, integration, and adaptation, to help them adapt to this ever-changing environment. Several company owners have taken an interest in supply chain apps that has resulted in the creation and deployment of specialist apps that improve supply chain flow control. Because of its flexibility to adjust to changing market situations and business environments, blockchain technology is drawing a lot of interest from company owners as a notable new use in the supply chain. After doing this, you will have a better grasp of how blockchain technology has changed this field. To enhance supply chain security, flexibility and transparency, the study report recommends that firms use blockchain technology. Without a doubt, blockchain technology is vital in building confidence among those involved in the supply chain. The paper concludes by outlining some of the potential positive outcomes that might result from implementing blockchain technology in areas such as increased competitiveness, flow management, and cooperation and integration.

Keywords— *Blockchain, Stakeholders, collaboration and integration, supply chain*

I. INTRODUCTION

Most multinational firms have struggled with supply chain complexity. Large investments by these companies lead to inefficiency and the search for cost-saving measures [1–5]. Businesses anticipate advancements in blockchain techniques, which could support improvements in the supply network. Experts suggest that blockchain technology may enhance supply chain efficiency, trust, and transparency in structure [6–10]. Furthermore, many supply chain executives believe that blockchain technologies would shape the future of the supply chain. The 2019 Pwc survey indicated that over 24% of industrial production companies aimed to incorporate blockchain technology into the supply chain systems. Additionally, more than 55% of top executives and practitioners at Deloitte, polled worldwide in 2020, regarded blockchain as a promising technology and their top objective [11–13].

Figures 1-3 demonstrate the value of blockchain technology in the 4.0 industry due to its distributed, safe

characteristics. The technique has attracted interest in both companies and educational institutions [14]. As a distributed ledger technology, blockchain ensures rapid and safe reimbursement of financial dealings & transfers at a very low expense. Furthermore, blockchain is not a novel internet infrastructure but rather highly innovative around supply chain networks, providing the next generation of business [15].

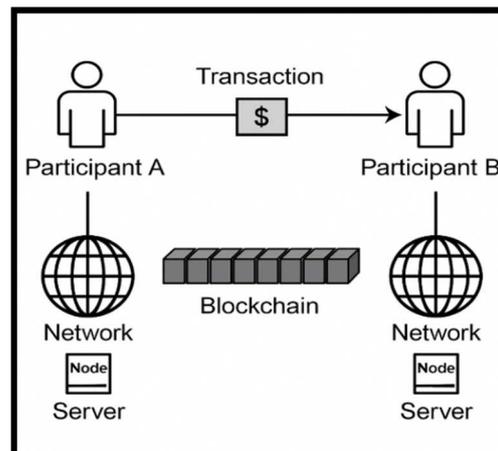


Fig. 1. Blockchain Technology Concept

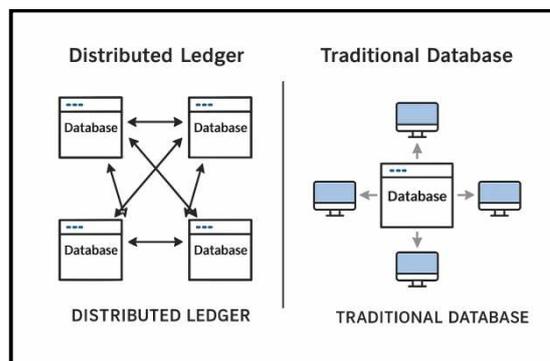


Fig. 2. Blockchain Building

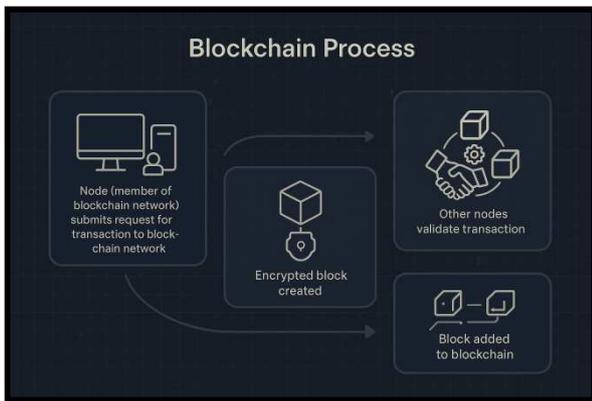


Fig. 3. Blockchain process flow simulation

A. Definition Of Blockchain

Encrypted data blocks contain locked data that only those having the key can access the data. Each file in the chain is associated with a certain time and date, and the chain of several businesses works together to create supply chain networks, which include various kinds of flow, including monetary, informational, and physical goods. Collaborating with every aspect of the company and integrating the processes will help improve the overall performance and provide a competitive edge for several organisations. The literature study of the blockchain investigated the strong qualities applicable in many domains. Blockchain model and its potential to improve supply chain integration and cooperation have also been covered in the research. Key concepts, including transparency, immutability, incapacity, and compliance, are explored in this study. Additionally, it agreed with the fact that blockchain technology and its potential to bolster supply chain management advantages are the main subjects covered. Additionally, the cause has mentioned that blockchain is a growing technology, therefore, the expert should get the chance to show how it might change the supply chain. On top of that, many have investigated smart contracts and how they may work inside the conventional framework. Smart contracts, namely, how to input data into the blockchain, are also the subject of ongoing investigations. However, other experts disagree that the blockchain implementation is an autonomous application that significantly reduces the cost of conventional software. Researchers agree that integrating blockchain in IoT devices decreases costs an entire consists of a large number of interconnected files, and the prior data regarding the blocks in the blockchain. The blockchain combines all the blocks.

B. Blockchain Infrastructure

Blockchain technology is only accessible via internet-connected devices such as computers, laptops, or servers. When all of these devices are linked, they are called nodes on the blockchain. The nodes store blockchain and provide authorisation for specific users who are included in the supply chain blockchain study. The process of storing information in a blockchain across nodes network which can be accessed from anywhere in the world, creates a ledger institution. Standard databases are utilised to compare the shared database where the digital information is housed in a central site, whereas in blockchain, the nodes save same data.

C. Addition of Blockchain

Incorporating information into a block of the blockchain requires delivering a node to make the transition needed in the

information being combined to other nodes of the chain for the blockchain to initiate block formation. New blocks must be validated before being added to the blockchain. In addition to the new node, it verifies that the block has the correct format and doesn't include any duplicate transactions. Once an encryption block is uploaded to both the blockchain as well as the blockchain system & the remaining nodes store it. The blockchain's encryption and distributed ledger structure prevent data hacking, promoting trust and confidence in data related to the blockchain.

D. Research Objective

This investigation aims on the benefits of blockchain technology in logistical firms. Although blockchain has only recently emerged, a lot of people had no prior understanding of this advancement, but this paper has educated the audience on the advancement of blockchain technique and its advanced benefits to supply chain management.

E. Research Motivation

The supply chain includes several items from independent farmers who distribute to customers. These factors lead the company to fall short in the competition. Although businesses operate independently, they are often connected to a vast supply chain network. As a result of globalisation and customers' high expectations, businesses are also facing difficulties related to uncertainty. One can find, there is a complicated supply chain which necessitates coordination between supplier networks, as well as intense competitiveness in the market. Fragmented supply chains arise from internal rivalry and inadequate information sharing. Other than that, this blockchain technology may provide a solution to difficulties such as high operating costs and capacity storage, which can significantly impact corporate performance.

F. Research Gap

Although there are many benefits of employing blockchain technology, it does not yet provide an entire solution for supply chain management. Technology that depends on blockchain and similar systems has various issues. The initiative aims to tackle issues around supply modification, and the blockchain-based supply chain network requires many legislative standards. Furthermore, the current blockchain infrastructure fails to achieve the extensive level of transaction speed necessary for the supply chain structure. Several different people form the supply chain. Incentives such as efficiency improvements are essential to enhance liquidity and data security. Privacy and security are additional major concerns with blockchain technology. The modern Internet of Things (Iot) system is based on a central model that works out, connects, & validates the Iot devices; however, there are problems with the data generated by the Iot. Therefore, it is crucial to consider the change when analysing blockchain technology.

II. LITERATURE REVIEW

A. Blockchain in Supply Chain Administration

1) Blockchain Technology Definition and Its Limitations

Blockchain, a distributed record database, stores records of transactions and digital occurrences done by participants. In recent times, there have been a several publications that aim to demonstrate blockchain technique and its features. Bitcoin is one of the most well-known cryptocurrencies that uses blockchain technology. Other than these digital currencies, there are other blockchain's potential effects in industries,

include manufacturing, finance, and supply chains. This study has focused on the application of blockchain in supply chain network instead of examining the technical operation of blockchain innovation. Important features of blockchain technology, such as its algorithms, hash function and signatures have been excluded from the study.

2) Supply Chain Management Definition & Its Boundaries

Supply chain methods involve managing the integrated flow of commodities from raw material suppliers to clients, including manufacturing, storage, and transportation. Determining its limits is essential in supply chain management, which incorporates some techniques. This study covers supply chain operations, including supply, production, distribution, and customer-related activities. Apart from this, supply chain management additionally examines the technique of the entire chain in the research.

3) Blockchain-Driven Supply Chain

Both the global and logistical implementation of blockchain technology are filled with uncertainties. This is due to blockchain's lack of maturity; the technology aims to revolutionise SC operations by facilitating more transparency and taking responsibility. According to, transparency is vital for traceability. Three forms of transparency have been identified in an SC. They are a spectrum of visible devices, transparency, and participatory transparency. To evaluate the hidden benefits or losses, it is important to analyse the SC transparency factor as well as how it correlates with opportunity and list viewpoint assessment. This will aid in implementing blockchain-based SC's. Understanding the use of blockchain innovation in the logistics sector needs a multidisciplinary approach so that theories may be created and developed for blockchain technology. Additionally, businesses may gain from sustainability and social responsibility using the blockchain to improve transparency and guarantee due diligence. Studies have shown a lack of awareness and comprehension of blockchain technology as well as a labour skill gap in this technology which needs to be addressed. Furthermore, it is essential that the proper consideration of blockchain technology in both business and technology provide adequate consideration, since there are significant prospects for this technology which might result towards its widespread application among the industry. Blockchain technology may assist to meet the seven goals of supply chain management: cost, quality, speed, dependency, risk reduction, sustainability as well as flexibility has discussed blockchain technology as a capability to break down data barriers and provide a single source of data in digitization as part of real-time data control which is required for all trusted partners in the network. In addition to the apparent advantages in security and trustworthiness that blockchain technology offers, there are a number of business values which might aid in the development of trust through the improvement of efficiency, reputation, and responsiveness. Blockchain significantly improves supply chain performance, provides benefits in operation management when compared to conventional methods. It is important to determine the optimum combination of enterprise resource planning (ERP), radio frequency identification (RFID), and blockchain technology in order to achieve maximum effect and impact, since each of these technologies are considered complimentary.

There are four obstacles towards blockchain-enabled SC development: organizational, technological, and external elements. Despite these challenges, blockchain technology is undeniably valuable as the SC's digital transformation engine.

4) Blockchain Technology And Transparent Supply Chain

Based on transparency, traceability, and irreversibility of transaction data, blockchain is rather significant in tackling two key problems in the supply chain area as shown in Fig 4 and 5. Supply chain challenges involve insufficient information transparency, difficulty in claiming responsibility and difficult to eliminate product quality due to multi-zone and long-term logistics. Blockchain is essential for enhanced monitoring and reporting; it additionally permits greater transparency in logistics. Furthermore, the firm may benefit by hastening the delivery schedule. Wide spread of goods increases the risk of mismatch, conflict, and inconsistency in the traditional fashion supply chain. Integrating GPS-based vehicle monitoring with blockchain technology might reduce this problem. Furthermore, as vehicle location monitoring helps to save costs and improve efficiency, blockchain technology is an attractive option in logistics additionally. Blockchain technology has immense advantages in the manufacturing industry because it guarantees confidentiality, transparency, and stability without the need for a central data storage system. Blockchain technology offers promising outcomes in organisation and economic parameters, surpassing old, centralized options.

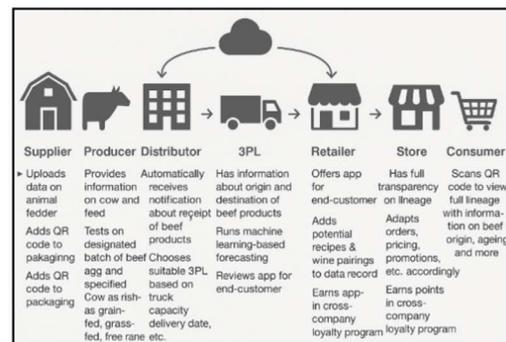


Fig. 4. Block-Chain Based on Supply Chain Management

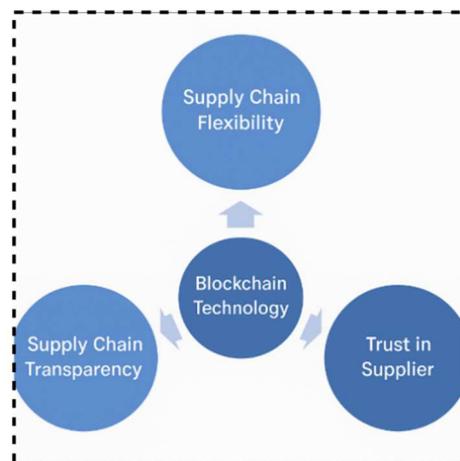


Fig. 5. Blockchain usage in Supply Chain

5) Blockchain Technology & supply chain flexibility

In today's corporate world, supply chain operations face greater complexity and uncertainty as compared to past

generations. Customer expectations are high due to product variety and short life cycles. Supply chain flexibility is crucial in adapting to alterations in the environment and dealing with these areas. Adaptability in the supply chain could satisfy and respond to a broad consumer base to get a competitive edge versus rival. Certainly, the company has encountered an extremely ambitious scenario because of its continuous growth. The government might improve flexibility to adjust rapidly to changes caused by inadequate information. Flexible supply chains are necessary for businesses to maintain a competitive edge in a dynamic, uncertain, and unpredictable world. Additionally, a flexible supply chain ensures effective distribution and product transfer to the market in sufficient quantities. Improving the supply chain might help in dealing with environmental concerns as business transactions become more unpredictable and worldwide. Effectively adapting to disruptions and demand allows organisations to achieve supply chain flexibility and meet consumer needs, outperforming competitors. Rapid economic development along with technological development should be highlighted if internal and external supply chains have become flexible. Firms with a versatile supply chain can easily adapt to unexpected conditions with simplicity. In addition, a flexible supply chain may improve the capacity of the organisation to effectively and clearly show the product and services to the consumer and fulfil their requests. The ability to trace and monitor a product's progress across various phases makes blockchain technology an ideal tool for achieving versatility. Blockchain technology's application across the supply chain occurs in expected points of interaction.

Blockchain technology provides secure data management for all supply transactions. Besides this, it might increase the supply chain visibility and provide network real-time data exchange. Thus, by accommodating the many stakeholders impacted by an outage, the blockchain might help in achieving supply chain flexibility. Improvements in manufacturing and management, as well as integration of supply chain operations, are all feasible due to innovations in technology, leading to more efficient inventory and supply management. Using blockchain model in the supply chain structure has an additional advantage: it may provide the design-related papers that need to be distributed. Improved decision-making in the supply chain may be accomplished by providing documents easily to all competitors.

B. Current Challenges

The research has highlighted blockchain's use in supply chain management. The deployment of blockchain technology is expected to revolutionise the supply chain in the future, despite its early stage. The academic community is optimistic regarding blockchain technology due to numerous good outcomes which have been anticipated by its application in supply chain management. Lots of research on blockchain in supply chain management are developing.

III. METHODOLOGY

A. Materials and Methods

1) Research Methodology

This research study uses a literature review approach to address the research areas. Although the study has drawn attention to the fact that several review articles have discussed

blockchain's technological features as they pertain to the supply chain, it has not drawn any firm conclusions in the management of the supply chain overall. The study paper just offered the foundation of the investigation. A systematic, clear, and repeatable review of the literature is a method for reviewing and assessing recorded materials. A survey of study findings in blockchain technology's potential uses in SCM is presented in this paper. Additionally, an extensive blockchain investigation and practical application will enhance understanding of the technology and its effect on supply chain management.

2) Research Framework

Researchers are allowed to utilize qualitative methods, quantitative data, or a combination of the two in their investigations. The qualitative research technique uses interpretive methodology as this type of research is appropriate for studies where new perceptions are needed to be obtained from present information, or when the phenomenon is not much understood. Accordingly, the qualitative approach is the best approach to use while studying blockchain technology & its function in SCM. The study will use a qualitative analysis strategy as it seeks to test the way utilising blockchain in supply chain management affects multiple aspects.

3) Data Collection

In the search process, there are a pair of keywords: supply chain and blockchain. The research topic of this research paper depends on the preceding seven years, with the goal of choosing topics which are like those of previous studies. Journals including Emerald, Google Scholar, study Gate, Science Direct, Taylor & Francis, Elsevier & Wiley Online were considered for study. Among the 441 papers retrieved, 285 were removed due to duplication & 116 were not related to the problem. After choosing 156 potential materials, the grey study article mainly chooses 40 for additional discussion. Consideration of high-quality, peer-reviewed journal papers has been given to the development of interactions among the research fellows. The report incorporates conference papers, consulting reports, along with third-party reports to update information on the early stage of blockchain, where few published articles exist.

In cases where the abstract of a particular research was unavailable, the paper has also evaluated the entire paper to determine its importance.

4) Study Selection and Evaluation

Based on pre-defined exclusion and inclusion criteria, the author has effectively examined the worthiness of the literature. The bibliographic manager has used the exclusion criteria before presenting the material. The author evaluated grey literature by reviewing the summary of the research study in the introduction. The research included a full-text review & omitted more than one paper. The discussion has clarified any difference in the significance of the items examined until agreement was reached.

Furthermore, other research was excluded due to their lack of focus on the technical aspects of the blockchain technique & blockchain structure. They are eliminated since all these papers failed to meet the initial requirements and they are incorporated in the paper's introduction.

IV. RESULTS AND DISCUSSION

A. Results

The current supply chain has undeniably gained from technological advancements; yet the following represent some of the major issues that contemporary supply chain management faces:

1) *Complex Ecosystem:*

Operating in regional, national and worldwide levels, the global firm has a complex network of suppliers as well as registered channels.

2) *Lack of Traceability:*

Poor traceability makes it difficult for the supply network to identify the source.

3) *Improper Response:*

Failures may occur if the operating company's processes vary from the regulations of the particular nation.

4) *Poor Visibility:*

Once the procedure begins, the company cannot trace the items in transit using barcodes.

5) *Data Reconciliation:*

Data reconciliation issues may arise due to varying logging methods in different processes.

6) *Lack Of Trust:*

Lack of transparency may lead to distrust in both the system and its operation.

The study paper emphasizes that complexities is the main root of these issues. Companies with fewer suppliers have a clear understanding of expectations and communication channels during issues. However, the corporate ecosystem has evolved over the years, and now its stakeholders are opaque to one another and the complex supply chain that supports them. Additionally, the organization is unaware of each other's declared activities, which raises the risk factor. The marketplace has become so large and complex that the company can't possibly return to its previous methods of carrying out business. Finding a new approach which will promote accessibility and encourage trust between the businesses would assist to overcome the issue. One key issue for supply chain firms is end-to-end monitoring. The difficulty of identifying inventory location & condition limits estimating customer demand and tracking transport capacity. Additionally, this leads to inadequate end-to-end visibility, which might put the organization at risk of interruption when dealing with global supply chains affected by geopolitical crisis.

Lacking a clear supply chain, the organisation might experience significant losses as they are lacking accurate data to determine how to manage disturbance. Blockchain ensures safe online transactions, making it the ideal solution for supply chain management organizations. Beyond this, technology makes it easy to obtain all the product information, which helps towards giving good support to the consumer. The technology is also highly recognized for openness in the linkages of the many sectors of the supply chain as well as honesty and transparency. In addition, blockchain technology facilitates the discovery of chain flaws and the rapidity of commodities movement. The technology offers extensive security and transparency opportunities. Firms through blockchain technology can track the shifts as well as record

any modifications created and the reasons behind them. They can monitor the alterations as the goods in the chain have a certain version of the registry and they will not face any dispute about dealings in the supply chain making the contract process successful. Information is stored in the ledger across shipment of the goods and acceptance of the smart contract. Next, the data is appropriately annotated with details like when and by whom it was generated, as well as whether it was hard to copy.

Additionally, firms that have accessibility to this ledger might observe current item ownership. The study has also covered how mobile technologies, and the internet of things may be handled with blockchain to create a real-time shipment monitoring system. An alternative to manual product tracking is the use of digital sensors to monitor shipments at each stage of the supply chain. Combining blockchain and IoT in logistics may reduce delivery time and improve tracking of goods. Incorporating tiny sensors within the items allows the organization to maintain an accurate and up-to-date inventory. The smart inventory can offer you plenty of useful data about the objects, which means when they were last on site, where they were stored, and much more besides. Important properties of digital ledgers may be adopted by the supply chain. It showed that blockchain guarantees visibility, authenticity, security, and transparency. However, blockchain properties such as decentralization, security, visibility, and trust in the supply chain have been examined. According to the characteristics of blockchain consist of persistence, decentralization & commercial properties. Building trust is a crucial aspect of an enterprise network that blockchain might help in the domain of supply chains.

Table 1 shows the key supply chain problems severity levels. This table summarises current supply chain management's biggest difficulties and rates their severity from 1 to 10. Each issue's severity level reflects the extent to which it hinders the supply chain's responsiveness, transparency, and efficiency. A high complexity score of 8 indicates that coordination is difficult due to worldwide interconnection and a broad network of suppliers. The sector struggles to track items across the supply chain with ratings of 7 for traceability and visibility. Response and trust scored 6, indicating low compliance with laws and inter-organizational transparency issues. Data reconciliation is a significant difficulty, particularly in processes using multiple data recording systems, while having the lowest score of 5. Considering all of these considerations, it is clear that technology solutions such as blockchain must be implemented immediately to improve transparency, data veracity, and stakeholder confidence.

TABLE I. KEY SUPPLY CHAIN PROBLEMS SEVERITY LEVELS

Supply Chain Issue	Severity Level (1–10)	Remarks
<i>Complexity</i>	8	High interdependence across global networks
<i>Traceability</i>	7	Difficulty tracking source of goods and raw materials
<i>Response</i>	6	Regulatory mismatches and slow adaptation
<i>Visibility</i>	7	Lack of real-time data on goods in transit
<i>Data Reconciliation</i>	5	Inconsistent logging methods across stages
<i>Trust</i>	6	Low stakeholder confidence due to transparency issues

Figure 6 demonstrates the current supply chain management issues. Important supply chain issues are shown in the bar chart with their severity levels, from 0 to 10, illustrating their relative importance. This bar chart breaks down supply chain performance into its component parts, with each horizontal bar representing a different problem and its relative importance. The complexity of maintaining a worldwide linked supply network is shown by the observation that it is the most severe obstacles, with a score of 8. The next three criteria all received 7, highlighting the persistent difficulties of monitoring products in real-time, responding to regulatory demands, and traceability. Trust and data reconciliation received scores of 6 and 5, respectively, suggesting significant problems with transparency as well as uniformity in data across systems.

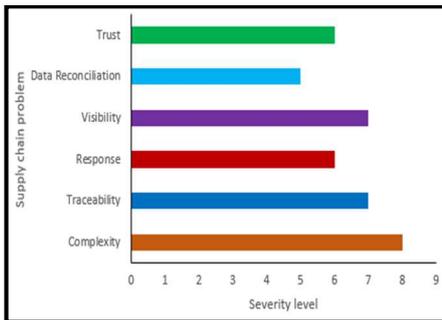


Fig. 6. Current Supply Chain Management Issues

V. DISCUSSION

Table 2 depicts the deployment of blockchain technology using new technologies in supply chain management of cutting-edge innovation. Despite its early stages, blockchain technology can be incorporated into other technologies like robotics, 5G, IoT, 3D printing & big data in the 4.0 era. The IoT system can be utilised with blockchain technology to improve traceability by gathering data, enabling both customers and merchants to monitor every step of the procurement process. Other applications involve monitoring the location of raw materials and keeping track on the transportation process using machine learning models. Adding sensors to the system may maximize the opportunity for providing traceability statistics. Furthermore, combining the earlier mentioned technology with blockchain would allow various characteristics to be benefited by organizing the logistical resources using the Internet of Things (IoT) availability. Therefore, the customer may quickly determine the shipping status without any trouble.

TABLE II. INCORPORATION OF BLOCKCHAIN TECHNOLOGY USING NEW TECHNOLOGIES IN SUPPLY CHAIN MANAGEMENT OF CUTTING-EDGE INNOVATION.

Technology	Integration with Blockchain	Key Benefits	Application Area
<i>Internet of Things (IoT)</i>	Real-time data collection linked to immutable blockchain records	Enhanced traceability, real-time shipment tracking	Inventory and logistics monitoring
<i>5G</i>	Enables fast, low-latency data transfer to support blockchain nodes	Reliable, scalable communication for real-time supply chain visibility	High-speed global supply chain networks
<i>Robotics</i>	Automates warehousing and smart contracts execution	Improves precision, reduces labor cost, enhances automation	Smart warehouses and fulfillment centers
<i>3D Printing</i>	On-demand production with blockchain-certified design files	Reduces counterfeit risk, ensures authenticity and version control	Decentralized manufacturing and prototyping
<i>Big Data</i>	Analyzes blockchain-logged transactions for predictive insights	Better decision-making, demand forecasting, and anomaly detection	Strategic planning and risk management
<i>Sensors</i>	Integrated with IoT and blockchain for tracking material condition	Enables detailed environmental tracking (e.g., temperature, damage)	Cold chain and perishable goods
<i>Machine Learning</i>	Trains models using historical blockchain data for pattern detection	Optimised route planning, disruption prediction, and fraud detection	Intelligent logistics and risk mitigation

VI. CONCLUSION

Several businesses work together to create supply chain networks, which include various kinds of flow, including monetary, informational, and physical goods. Collaborating with every aspect of the company and integrating the processes will help improve the overall performance and provide a competitive edge for several organisations. The literature study of the blockchain investigated the strong qualities applicable in many domains. In addition, the study has discussed the blockchain technology along with how it may improve integration and cooperation in the supply chain. This study brings together the key topics of amenability, disability, immutability & transparency. It also accepts the reality that the primary topics are included in the blockchain and the way it may support the benefits of supply chain management. The cause has also indicated that the blockchain is one of the developing technologies, and the expert should be allowed to demonstrate that it can alter the supply chain. Furthermore, the general public has investigated smart

contracts and their probable usefulness in the current traditional framework. Investigations are also being performed on digital contracts regarding how one may enter data into the blockchain. However, other experts disagree that the blockchain implementation is an autonomous application that significantly reduces the cost of conventional software. Researchers agree that integrating blockchain in Iot devices decreases costs.

A. Future Work

Blockchain, an emerging technology, may enhance supply chain business, but it cannot disrupt the business ecosystem independently. The study article has shown yet that technology can provide recommendations and guidance for future path as well as a few proposed paths. The main goal is to monitor high-level business demands, including capability needs. Consideration of emerging technologies for communication and information is the second component in a technological qualitative study, which will lead to the development of innovative services. Finally, the authors emphasised the need to apply blockchain with other technologies, including the Iot, 3d printing, smart contracts and requested the end user to provide suggestions on the many services. Research and government officials both would benefit from a better grasp of blockchain technology and its prospective uses in supply chain business and organization.

REFERENCE

- [1] Saberi, Sara, et al. "Blockchain technology and its relationships to sustainable supply chain management." *International journal of production research* 57.7 (2019): 2117-2135.
- [2] Korpela, Kari, Jukka Hallikas, and Tomi Dahlberg. "Digital supply chain transformation toward blockchain integration." (2017).
- [3] Rejeb, Abderahman, John G. Keogh, and Horst Treiblmaier. "Leveraging the internet of things and blockchain technology in supply chain management." *Future Internet* 11.7 (2019): 161.
- [4] Cole, Rosanna, Mark Stevenson, and James Aitken. "Blockchain technology: implications for operations and supply chain management." *Supply chain management: An international journal* 24.4 (2019): 469-483.
- [5] Wang, Michael, et al. "Blockchain and supply chain management: a new paradigm for supply chain integration and collaboration." *Operations and Supply Chain Management: An International Journal* 14.1 (2020): 111-122.
- [6] Akyuz, Goknur Arzu, and Guner Gursoy. "Transformation of supply chain activities in blockchain environment." *Digital business strategies in blockchain ecosystems: Transformational design and future of global business* (2019): 153-175.
- [7] Bhau, Gaikar Vilas, et al. "IoT based solar energy monitoring system." *Materials Today: Proceedings* 80 (2023): 3697-3701.
- [8] Lyasnikov, Nikolai V., et al. "Blockchain technology: supply chain management." *The IIOAB Journal* 11.3 (2020): 1-7.
- [9] Luo, C., et al. "Laser Heat Treatment of Low-Alloy Ultrahigh-Strength Steel Laser-Welded Joints." *Welding Journal* 8 (2019): 98.
- [10] Wamba, Samuel Fosso, and Maciel M. Queiroz. "Blockchain in the operations and supply chain management: Benefits, challenges and future research opportunities." *International Journal of Information Management* 52 (2020): 102064.
- [11] Renukaradhya, Sapna, Sheshappa Shagathur Narayanappa, and Pravinth Raja. "RESNET-50 with ontological visual features based medicinal plants classification." *Network: Computation in Neural Systems* (2025): 1-37..
- [12] Dursun, Taner, et al. "Blockchain technology for supply chain management." *Industrial Engineering in the Internet-of-Things World: Selected Papers from the Virtual Global Joint Conference on Industrial Engineering and Its Application Areas, GJCIE 2020, August 14–15, 2020*. Springer International Publishing, 2022.
- [13] Balamurugan, J., et al. "Design and Development of AI Neuromorphic to Control the Autonomous Driving System." *Integrating Neurocomputing with Artificial Intelligence* (2025): 87-103.
- [14] Kumar, Rajeev, and Dilip Kumar. "Blockchain-based smart dairy supply chain: catching the momentum for digital transformation." *Journal of Agribusiness in Developing and Emerging Economies* 15.2 (2025): 225-248.
- [15] Kawaguchi, Natsuki. "Application of blockchain to supply chain: Flexible blockchain technology." *Procedia Computer Science* 164 (2019): 143-148.