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# BLOCKCHAIN TECHNOLOGY IN SUPPLY CHAIN MANAGEMENT

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## ABSTRACT

This paper aims to fill the gap in existing research by examining the impact of blockchain technology on supply chain management, particularly its ability to retrospectively trace events in the chain. For example, in pharmaceuticals, blockchain automatically records information like expiration dates, reducing the need for human involvement. By implementing this backward technology, we've simplified processes for suppliers and manufacturers, allowing the system to identify defective or expired items autonomously, saving time and costs. Previously, the supply chain operated as a one-way system without return options, but now, with blockchain integration, relevant parties are informed about necessary replacements from the manufacturer's end.

Blockchain's integration into supply chain management is a significant advancement, offering unparalleled transparency, traceability, and security in logistics and distribution. This article explores how blockchain can revolutionize established supply chain practices, delving into applications like tracing goods from origin to destination, using smart contracts for automated agreements, and secure data exchange while protecting privacy. Case studies highlight advantages such as reduced expenses, risks, and improved compliance.

Blockchain, as a decentralized ledger system, provides instant, unchangeable record-keeping and cryptographic validation, instilling confidence among stakeholders. In supply chain management, this means identifiable product origins, better tracking, less fraud, and quicker dispute resolution. However, challenges like scalability, energy use, and network interoperability exist, underscoring the need for industry collaboration and standardization efforts.

In recent years, blockchain has emerged as a promising solution for enhancing transparency, security, and efficiency across industries, notably in supply chain management. This research explores blockchain's applications, benefits, challenges, and future potential in transforming supply chain processes, highlighting its decentralized, secure ledger system as a cornerstone for trust and reliability.

## INTRODUCTION

Previously, in the supply chain, data storage was limited to materials flowing from manufacturers to suppliers. However, the integration of blockchain technology has expanded tracking capabilities to include backward material flow. For instance, expired pharmaceutical products can now be automatically flagged to both parties, reducing waste and simplifying restocking procedures, thereby ensuring continuous product availability. My research primarily focuses on facilitating smooth market flow and effortless product replacement, ultimately streamlining production with minimal labor input.

Blockchain technology in supply chain management aims to achieve various objectives, such as improving transparency, traceability, security, efficiency, and counterfeit prevention. It creates transparent and tamper-resistant records of all supply chain activities, allowing stakeholders to monitor product movement from inception to delivery, authenticate their legitimacy, and enhance security measures. Automation through smart contracts streamlines operations while ensuring data integrity and auditability.

## EXISTING SUPPLY CHAIN

The operation of a supply chain is a intricate process that entails coordinating and overseeing a multitude of tasks and stakeholders to transport a product or service from its raw materials stage to the ultimate consumer. It encompasses the movement of goods, services, and information from suppliers to end customers.

Essential Activities

1. Sourcing Raw Materials

2. Production

3. Inventory Management

4. Logistics and Transportation

5. Order Fulfilment Key Participants

- Suppliers

- Manufacturers

- Distributors

- Retailers

- End Customers

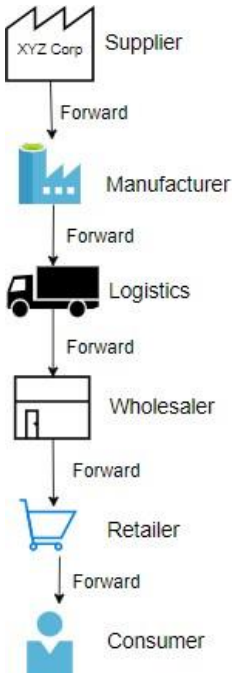


Figure 1 Existing supply chain

## DRAWBACKS IN EXISTING SUPPLY CHAIN

In the current supply chain, retailers often end up with excess materials, resulting in both product and financial waste. This issue is a significant concern in the market, as addressing it would enhance product availability and reduce unnecessary expenditure.

1.Lack of visibility, resulting in delays and inventory issues due to the inability to track goods and information in real-time.
2.Inefficient communication
3.Limited scalability, causing inefficiencies when handling large data volumes
4.Inability to adapt to disruptions resulting in delays and revenue loss.
5.High costs associated with establishing and maintaining a supply chain 6. Limited data analysis capabilities
7. Inefficient transportation
10. Supplier risks, such as insolvency or quality issues, affecting the overall supply chain.
11. Difficulty in balancing competing priorities like cost, quality, and speed, resulting in suboptimal decisions.

A supply chain encompasses all the stages required to deliver a final product or service to the end consumer. These stages typically involve procuring raw materials, transporting them to production facilities, and then delivering the finished goods to distribution centers. The parties involved in this process manufacturers, suppliers, warehouses, logistics companies, distribution centers, and retailers.

## INTEGRATED SUPPLY CHAIN

We aimed to integrate reverse logistics into the supply chain, a concept we successfully implemented. We acknowledged the limitations of both supply chain and blockchain technologies. However, by incorporating blockchain into supply chain management, our objective is to streamline processes, reduce labor requirements, and establish an efficient framework for the future.

Previously, the supply chain involved sequential steps: the supplier provided materials to the manufacturer, followed by regulator quality checks, logistics managing shipment, wholesaler stock management, and finally, consumption by the

consumer. With blockchain integration, reverse logistics come into play. Benefits:

1Enhanced transparency

2.Improved security

3. Cost reduction

4. Increased trust

A supply chain typically comprises independent organizations engaged in the flow of products, services, finances, and information from source to customer. Effective supply chain management requires collaboration and information sharing. BCT facilitates asset tracing back to their origins via a shared ledger containing visible and immutable records. Products and technical equipment maintain their integrity, with provenance information ensuring their authenticity. This promotes responsible sourcing and aids in detecting or preventing product counterfeiting and fraudulent activities. Potential applications include tracking ownership post-sales for warranty purposes. Moreover, BCT validates goods documentation, simplifying customs clearance, and streamlining other formalities in global trade.

Imagine fully autonomous supply chains operating based on predefined criteria, enabled by BCT's transparency, verification, and smart contract automation. Information and decisions are seamlessly communicated across the supply \chain, enhancing coordination and expediting processes. Machines can alert downstream partners of anticipated delays, request maintenance assistance, and order spare parts from suppliers in the event of breakdowns. Automation, known as post- enforcement, ensures contracts cannot be retroactively altered, paving the way for extending the Industry 4.0 smart factory concept to supply chains across various companies.

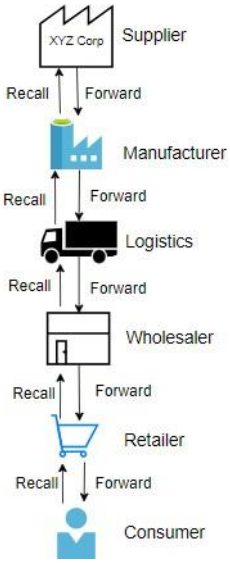


Figure 2 Key Factor of Integrated supply chain

## WORKING OF BLOCKCHAIN ARCHITECTURE

Decentralization: Blockchain technology functions through a decentralized system where a network of interconnected computers, or nodes, collaborates to validate and record transactions. This structure eliminates the need for a central authority or intermediary, ensuring secure and transparent transaction processing.


Figure 3 Features of Block Chain

Blocks and Transactions: A blockchain consists of interconnected blocks, linked via a unique code known as a "hash."

Consensus Mechanism: To maintain the integrity of the blockchain, a consensus mechanism is utilized to validate transactions and ensure unanimous agreement among nodes

Public Key Cryptography: Security in blockchain relies on public key cryptography, which generates a pair of keys for each network node.

Immutable Ledger: The blockchain serves as an immutable ledger, meaning once a transaction is recorded, it remains unchanged

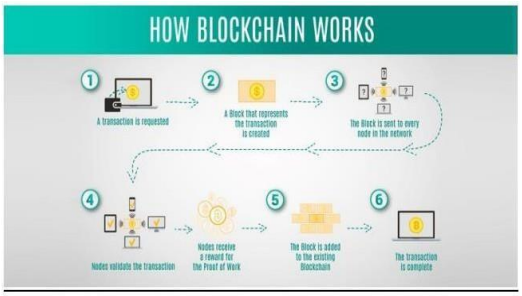


Figure 4 Working of Blockchain

## METHODOLOGY

This study revolves around a case study and employs a multi-case study. Since semi-structured interviews were used for data collection, the study falls under qualitative research, making the qualitative method the most appropriate research approach.

Understanding the relevance of blockchain and IoT within the industry context, with particular emphasis on respective norms and culture, is crucial. The integration of blockchain and IoT for enhancing product return management has the potential to improve reverse logistics practices, including compliance with social awareness and legislative guidelines. Traditional research literature typically relies on a single visualization software. We combined the advantages of CiteSpace and VOSviewer to depict document relationships.

## FUTURE AGENDA

Based on a thorough examination of the literature on Blockchain Technology (BT) in Supply Chains (SC), this study proposes a future research agenda aimed at advancing the field and addressing lingering questions for both management scholars and practitioners. Our comprehensive review underscores the significant potential of BT to revolutionize the management of supply chains, particularly in areas such as product tracking and tracing, transparency enhancement, trust building, risk management, and the establishment of secure supply chain environments. Moreover, our critical analysis extends the scope of BT application beyond tracking and tracing to encompass various industries, including construction, retail, pharmaceuticals, waste management, and others.

To structure our research agenda, we adopt Whetten's (1989) "5W and 1H approach," addressing questions related to "what, who, why, when, where, and how."

What. This delvs into the factors driving and hindering the adoption and implementation of Blockchain Technology

Why: This raises questions about the motivating factors behind the adoption and implementation of BT and their socio-economic implications.

How: This focuses on questions related to conducting investigations into the underlying processes explaining the impact of BT on SC, i.e., methods and methodologies.

Who: A fundamental aspect of blockchain is its ability to foster collaboration and trust among individuals who may be strangers, creating an environment conducive to interorganizational trust.

When: Timing plays a crucial role in the decision-making process for firms considering the adoption and implementation of BT.

Where: This section considers the context and application areas of BT, taking into account geographical, technological infrastructure, political, socio-economic, cultural, and legal influences..


Figure 5 3T's of SCM

Success stories and benefits achieved:

1. Walmart: For tracking the supply chain of green leafy vegetables, Walmart adopted blockchain technology, they were able to enhance food safety and decrease the impact of illnesses caused by food by reducing the period of time it takes to track down the source of infected product from weeks to a few seconds.

2. De Beers: To create a transparent and traceable supply chain for diamonds, De Beers, a mining and retail organization for diamonds, adopted blockchain technology.

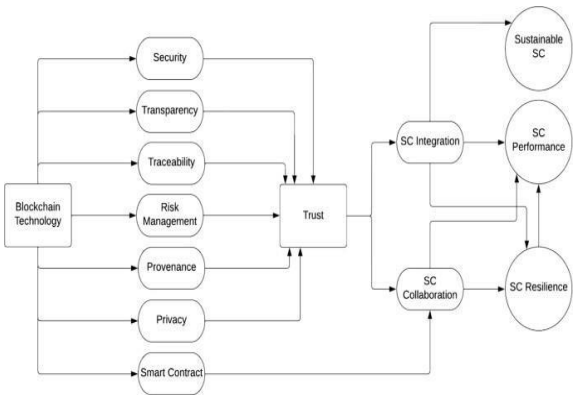

Figure 12. Implementation of Blockchain

Figure 6 Implementation of block chain

## Implications

When used in SCM, blockchain technology has many different implications. Managers will have much more power if they can effectively track and analyze carriers, goods and services. Blockchain technology makes payments easier, better at planning and optimizing supply chain networks, and makes supply chain operations less prone to fraud. Since the technology is flexible, it is possible to use different methods. This makes it more useful and covers the entire value chain. Smart contracts are used to ensure that things along the value chain are legitimate and that people have the right to access them. This makes the item less likely to be altered or illegally manipulated. Blockchain technology can be used for more than this. These days, sustainable supply chain management is more important than ever as people are concerned about the environment and the need to comply with regulations.

## CASE STUDY

This study is based on a case study and uses a multi-case study to draw its conclusions using the standard case study approach presented by (Goyt et al., 2019). The ability to conclude a series of cases is what makes multi-case studies important for studying phenomena that occur in different contexts. Since semi-structured interviews were used to collect data, this study can be characterized as a qualitative investigation.Questions about blockchain technology, its applications and the value it provides to businesses and their customers were common in the interviews. Managers with degrees and experience in technology tend to be respondents. The case company and its operations are the units of analysis. Researchers from Finland and Italy examined three example companies to determine the feasibility of blockchain technology. The primary objective was to investigate the consideration of the management of the case companies regarding the implementation of blockchain technology in their day-to-day operations. Financial services (such as trade finance) and supply chain (such as traceability and transactional services) were the two primary areas when considering how operational activities of case companies could be enhanced with blockchain technology.

While blockchain technology is still in its early stages of development and pilot programs, these case studies were used from a macro-level business case perspective. to illustrate its potential. The three case companies' background information is shown in Table 1.

**Table 1 Background information of the three case companies**

| Industry | Wood construction | Consulting and regional development | Technology |
|---|---|---|---|
| Country | Finland | Finland | Italy |
| Employee count | 20 | 42 | 5 |
| Utilization of blockchain | No | Yes | Yes |
| Purpose of utilization | - | Testing and piloting (technology diffusion) | Core technology (blockchain product) |

Blockchain use cases in the supply chain

There are many different applications of blockchain technology in supply chains. To ensure the necessary interaction between many participants (e.g. humans, machines, and systems), a blockchain-based supply chain has a consistent format. Predefined blockchain access permissions are maintained by all actors within the supply chain, while their usage responsibilities may vary. As a result, the right to access the blockchain can be divided according to needs. One more thing: blockchain can receive data directly from other sources, such as sensor data sent by IoT devices. Standardized blockchains like this one for the supply chain have the potential to increase trust, openness, and adaptability. Additionally, the end consumer of a good or service can benefit from blockchain technology. With blockchain data as a foundation, companies can implement innovative services and business models. In addition, businesses on the blockchain network can use the data for deeper study by analyzing it with machine learning algorithms. This research focused on three different industries. The results of the study are used to make the case for each industry.

Blockchain technology has several potential applications in the wood construction industry. The complex application of blockchain technology in the timber construction sector benefits all businesses involved in the value chain. In the timber construction sector, the client usually takes the lead. Additionally, this kind of blockchain opens up a new arena for progress in the construction sector. Consultancy and regional development form the second use case, as seen in Table 2.

**Table 2: Use case of block chain in the consulting and regional development industry**

| Stakeholder | Utilization of blockchain |
|---|---|
| Company | Management and distribution of different contracts. Overall development of blockchain solutions. |
| Marketing | Customer relationship management and marketing activities within the company. |
| Consultant | Customer background information utilization as part of the consulting process. |
| Customers | Management and distribution of different contracts. |

There are several ways in which consulting and regional development firms might put blockchain technology to use, and these techniques vary by industry. Blockchain solutions for the supply chain were developed and disseminated by the consultancy and regional development firm. Table 3 provides a summary of the third use case company, a tech firm that is likewise using blockchain as its foundational technology.

**Table 3 Use case of block chain in the technology industry**

| Stakeholder | Utilization of blockchain |
|---|---|
| Development and manufacturing company | Development of blockchain technology in the supply chain and management of different contracts. New innovative costumer solutions utilizing the blockchain. |
| Subcontracting | Sharing documents and plans between different stakeholders and other actors which provide value for a new technology. |
| Marketing | Utilization of the data which is part of the blockchain as marketing operations. Utilization of blockchain part of customer relationship management. |
| Distributor of the technology | Ordering the products from the company which is developing and utilizing blockchain in operations. Management of different contracts and agreements between the stakeholders. |
| Retailers and other product sellers | Receiving the data concerning the technology. Management of different contracts and customers. Recording and reading the data about warranties of the products sold. |
| Customer | Utilizing the data which is in the blockchain related to the technology purchased. |

## CONCLUSIONS AND SUMMARY

Blockchain technology is positioned to revolutionize logistics networks by promoting greater openness, data sharing, and enhanced services. Its management techniques show significant potential to improve stability, reduce fraud, and strengthen supply chain traceability.

Blockchain technology holds the potential to revolutionize supply chain management by addressing major industry challenges, offering transparency, security, and efficiency, fostering trust among partners, streamlining processes, and mitigating issues like fraud and counterfeiting through decentralized and immutable ledgers. Automation and security enhancements via smart contracts further improve efficiency, Nonetheless, blockchain adoption has gained traction across various organizations.

Despite its potential, blockchain technology faces several barriers in adoption

1. Integration Complexity

2. Scalability

3. Regulatory Compliance

4. Interoperability

Despite the challenges, the future of blockchain in supply chain management looks promising. Continued research and development efforts are focused on addressing scalability, interoperability, and regulatory concerns. As blockchain technology matures and becomes more widely adopted, it has the potential to revolutionize supply chain management .

Thus, blockchain can increase security and trust. To use the full potential of blockchain, new funds need to be deployed to solve diving problems such as cooperation of different participants of the chain, and make the existing good blockchain ecosystem profitable.

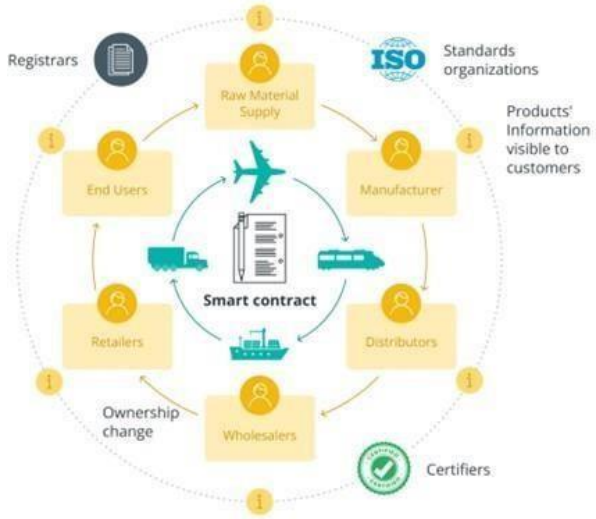


Figure 7 Key factor of blockchain based SC

## RESULTS

The study suggests that companies should invest in blockchain technology to enhance transparency, flexibility, and security within their supply chains. Additionally, it discusses the positive implications and potential of blockchain for collaboration and integration in the supply chain management (SCM) realm.As SCM moves into the era of big data, blockchain emerges as a disruptive force with the

potential to improve operational efficiency, data management, responsiveness, transparency, and smart contract management. The study highlights backward integration as a strategic maneuver wherein companies gain control over their supply chains by acquiring or merging with suppliers of raw materials or components, leading to cost savings and increased efficiency by eliminating intermediaries. However, based on the results of this study, trust is highly expected as a consequence of BCT. At the same time, Scalability and energy consumption are often flagged as a barrier to using blockchain technology. We found that external pressure and relative advantage are the two most prominent categories of enablers that impact blockchain adoption in the supply chain.

Blockchain technology offers several applications that can transform various aspects of supply chain management:

•Traceability and Transparency:

•Supply Chain Visibility

•Streamlined Transactions

•Counterfeit Prevention

•Enhanced Security

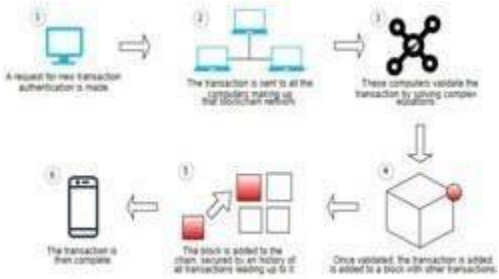

Figure 8 Transactional flow

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