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The use of technology for operational efficiency in supply chain management

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I. CHAPTER 1: INTRODUCTION

Supply chain management (SCM) is an integral part of any business that involves the movement of goods and services from one place to another. It encompasses a range of activities, from sourcing raw materials to delivering finished products to customers. However, the traditional supply chain management system is plagued with challenges such as a lack of transparency, traceability, and security.

In recent years, emerging technologies such as blockchain, machine learning (ML) and artificial intelligence (AI) have shown great promise in enhancing supply chain management's efficiency, security, and transparency. Blockchain technology, in particular, has gained popularity due to its ability to provide an immutable and secure ledger of transactions that can be shared among all participants in the supply chain.

This research paper explores the potential of blockchain technology, ML and AI in improving supply chain management. The paper will provide an overview of the current challenges faced by traditional supply chain management systems and how blockchain technology, ML and AI can address these challenges. Additionally, the paper will examine real-world examples of blockchain and AI in supply chain management and their impact on operational efficiency and security.

1.1 Research Objectives

- To determine the impact of AI on Supply Chain Management
- To determine the impact of Machine Learning on Supply Chain Management
- To determine the impact of Blockchain on Supply Chain Management

1.2 Research Questions

- How does AI increase the operational efficiency of the Supply Chain?
- How does Machine Learning increase the operational efficiency of the Supply Chain?
- How does Blockchain increase the operational efficiency of the Supply Chain?

II. CHAPTER 2: LITERATURE REVIEW

2.1 Operational Efficiency of Supply Chain

Technology has become an essential component of modern supply chain management. Its integration into the supply chain process has revolutionised how businesses manage their operations, enabling greater efficiency, lower costs, and improved customer satisfaction.

One of the significant benefits of using technology in supply chain management is improved transparency and visibility. By leveraging IoT sensors, RFID tags, and GPS technologies, businesses can track products' movement from the supplier to the customer. This tracking helps businesses optimise their supply chain processes, improve inventory management, and reduce delivery delays (Analyticsinsight.net, 2022). For example, Walmart implemented a sophisticated tracking system that allows it to monitor every item in its supply chain in real time. This system has enabled the company to reduce out-of-stock items by 16%, saving millions of dollars in lost sales annually (Donahue, 2022).

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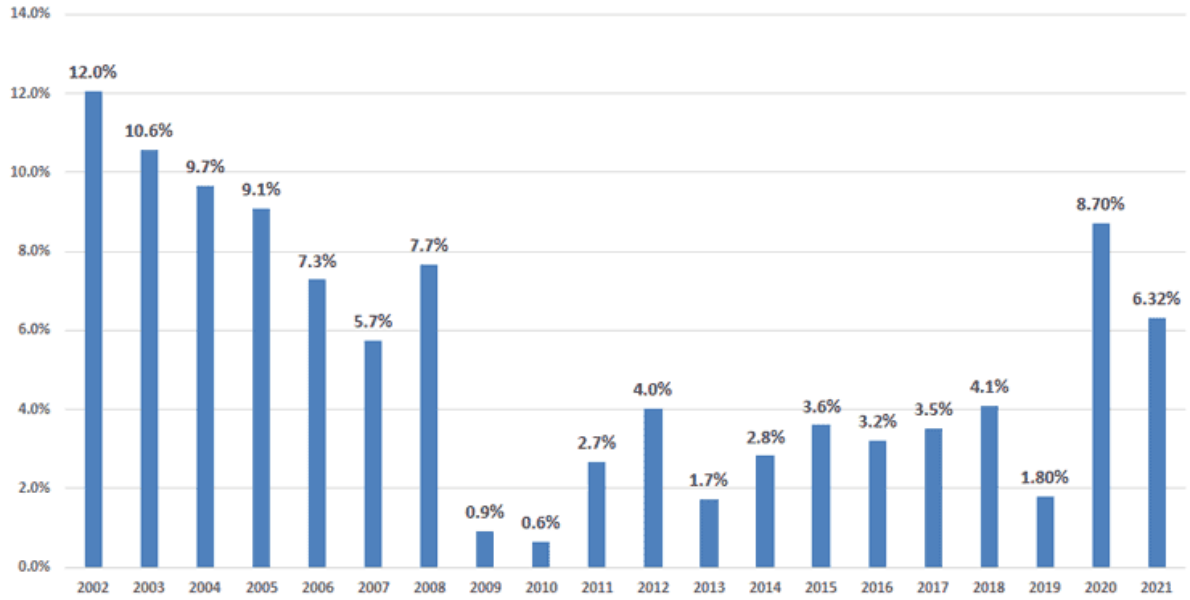

Figure 1: Walmart sales growth due to SCM operational efficiency

(Source: Donahue, 2022)

Technology can also improve the efficiency and productivity of supply chain operations. By automating routine tasks such as order processing, inventory management, and shipment tracking, businesses can free up time and resources to focus on more critical tasks such as customer service and product development (cnb.com, 2023). According to a survey by DHL, businesses that use technology in their supply chain management reported a 10% increase in productivity and a 9% reduction in costs (DHL.com, 2023).

Technology implementation in supply chain management also enhances collaboration and communication within the supply chain ecosystem. Using cloud-based collaboration tools, businesses can share information and data in real-time, allowing all parties to access the same information simultaneously (Rejeb et al. 2019). This collaboration helps to improve decision-making, reduce errors, and improve the overall efficiency of the supply chain. For example, Nestle implemented a cloud-based platform to improve supplier collaboration. This platform helped Nestle to reduce its inventory levels by 7% while increasing its on-time delivery rate by 25% (Nestle.com, 2023).

Figure 2: Nestle growth due to SCM efficiency

(Source: Nestle.com, 2023)

Technology also plays a vital role in improving customer service by providing businesses with real-time data on customer preferences, behaviour, and satisfaction levels. This data allows businesses to tailor their products and services to meet the specific needs of their customers, improving customer satisfaction and loyalty (Di Vaio and Varriale, 2020). For example, Amazon uses data analytics to personalise its product recommendations to individual customers. This strategy has helped the company to achieve a customer retention rate of 93% (Chevalier, 2021).

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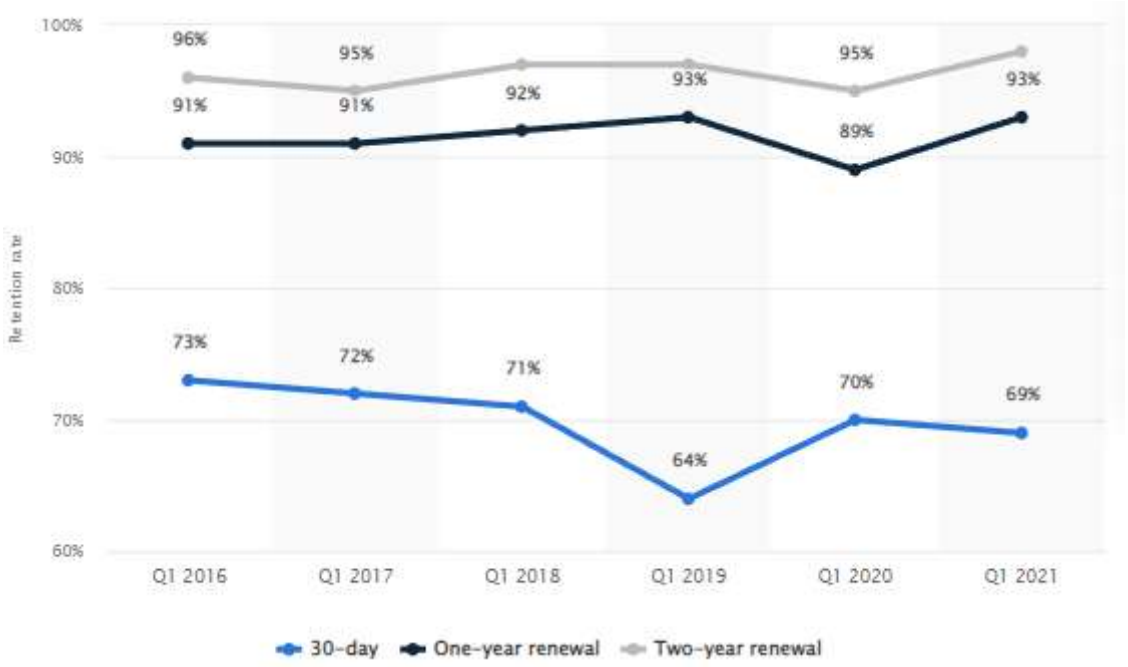

Figure 3: Amazon subscription retention rate

(Source: Chevalier, 2021)

2.2 AI in Supply Chain Management

Artificial intelligence (AI) is a branch of computer science concerned with creating computers that are capable of doing activities that would normally need human intellect (Helo and Hao, 2022). Artificial intelligence can analyse past sales figures, industry trends, and other pertinent data to properly forecast consumer demand. Business owners may use this demand forecasting to better plan production, decrease stockouts, and optimise inventory levels (Toorajipour et al. 2021). According to a study by Deloitte, AI-based demand forecasting can reduce forecasting errors by up to 50% (Columbus, 2020). AI is also used to optimise transportation routes, reducing transportation costs and improving delivery times. By analysing data such as traffic patterns, road conditions, and weather forecasts, AI algorithms can identify the most efficient route for each delivery. According to a study by DHL, route optimization using AI can reduce transportation costs by up to 10% (Dhl.com, 2022).

Moreover, AI improves the quality control process by analysing data from sensors and cameras to identify defects and other quality issues. By automating this process, businesses can improve the accuracy of their quality control inspections and reduce the time and resources required for manual inspections (Dash et al. 2019). According to a study by McKinsey, AI-based quality control can reduce defect rates by up to 90% (Mckinsey.com, 2017). AI also helps to predict when equipment and machinery will require maintenance, reducing downtime and maintenance costs. By analysing data such as machine performance, operating conditions, and maintenance history, AI algorithms can identify potential issues before they cause a breakdown (Modgil et al. 2022). According to a study by PwC, predictive AI maintenance can reduce maintenance costs by up to 30% (Pwc.nl, 2017).

2.3 Machine Learning in Supply Chain

Machine learning is a branch of AI that enables a computer programme or system to improve itself via trial and error rather than being explicitly taught how to do so. Data or observations are utilised in ML to train a computer model, which is then used to refine the technology based on an analysis of the data's patterns (along with actual and expected results) (Ni et al. 2020). Using machine learning in supply chain management, businesses may streamline various administrative chores and free up resources for more important and strategic endeavours (Aamer et al. 2020). Businesses need effective supply chains, and sophisticated machine learning software can help supply chain managers optimise inventories and locate the best possible suppliers (Baryannis et al. 2019).

Machine learning finds various uses in supply chain management because it relies on data.

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With machine learning, supply chain management may be optimised and streamlined. Businesses may use machine learning models to get results comparable to those of artificial intelligence in demand forecasting (Dash et al. 2019). These ML models excel at unearthing previously unknown connections between different pieces of demand history. Supply chain problems may be identified using machine learning far before they cause a major interruption to operations (Priore et al. 2019). For instance, Machine learning algorithms are being used by businesses like Amazon and Walmart to enhance demand forecasts. Walmart forecasts future demand efficiently using previous sales data and other pertinent information, allowing them to optimise inventory levels and enhance production scheduling (Dash et al. 2019). In order to optimise transportation routes, Walmart utilises machine learning algorithms. This decreases transportation costs and speeds delivery times (Baryannis et al. 2019).

Similarly, Amazon optimises its warehouse operations using machine learning algorithms to reduce delivery times and raise customer satisfaction. The corporation utilises machine learning algorithms to forecast demand trends, optimise inventory levels, and enhance the precision of its order fulfilment procedures. Amazon also optimises its transportation routes using machine learning algorithms, which lowers transportation costs and accelerates delivery times (Ni et al. 2020).

Moreover, Nestle uses machine learning algorithms to optimise its demand planning process, reducing inventory costs and improving production planning. The company uses historical sales data and other relevant data to predict future demand accurately, enabling it to optimise its inventory levels and improve its production planning. By using machine learning, Nestle has reduced inventory costs and improved operational efficiency (Ni et al. 2020).

2.4 Blockchain in Supply Chain

Blockchain technology is being employed progressively to increase transparency, traceability, and efficiency in the supply chain management process. A transparent and secure digital ledger that can monitor the passage of items from their place of origin to the final customer may be created using blockchain technology (Alazab et al. 2021). It also helps reduce supply chain fraud by providing a 100% tamper-proof system. For instance, Blockchain technology is being used by Everledger to trace the history of diamonds and confirm their authenticity. This lessens the possibility of fraud and helps guarantee that diamonds are mined ethically and conflict-free. It helps to check the items' validity and make sure nothing has been changed with them (Blossey et al. 2019).

Moreover, for example, IBM has created a food traceability technology based on blockchain that enables customers to trace the provenance of their food items. This increases supply chain trust and transparency and may also help cut down on food waste (Yang et al. 2021). Blockchain technology is also utilised to automate and digitise paperwork and record-keeping, streamlining supply chain operations. For instance, the Port of Rotterdam Authority in the Netherlands is digitising its paper-based cargo monitoring procedure using blockchain technology. As a result, human record-keeping has taken up less time and money, and freight monitoring is now more accurate and transparent (Roeck et al. 2020).

Companies can save millions on costs by implementing blockchain technology in their supply chain management. It helps by reducing the time and resources required for manual record-keeping and paperwork (Alazab et al. 2021). For example, the Port of Antwerp in Belgium has adopted blockchain technology to improve the accuracy and transparency of container monitoring while streamlining the time and resources needed for traditional documentation (Blossey et al. 2019).

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2.5 Conceptual Framework

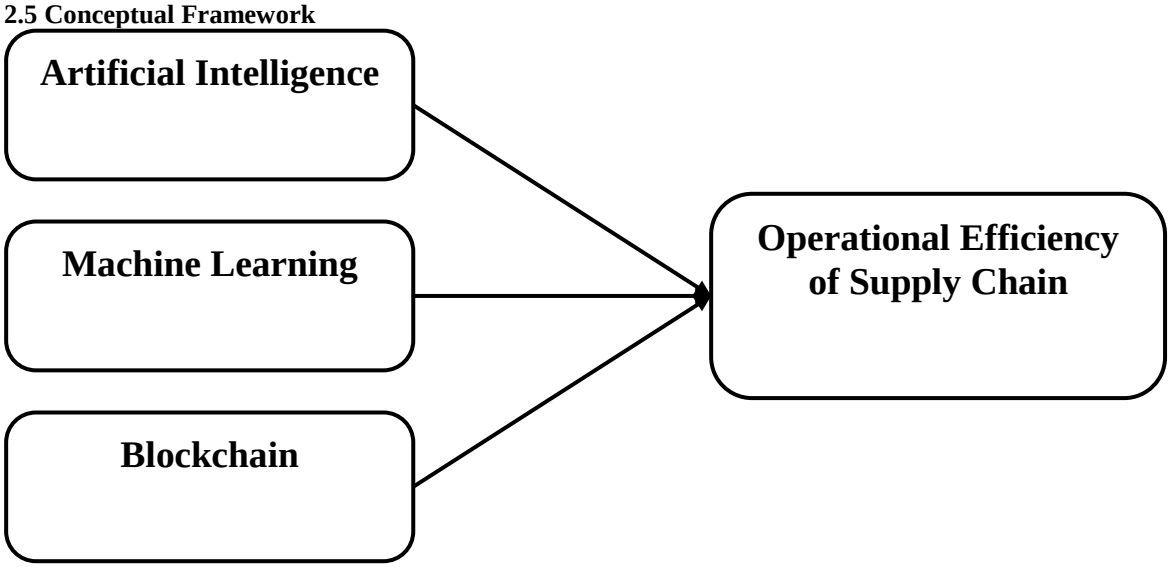

Figure 4: Conceptual Framework

(Source: Author)

2.6 Literature Gap

Lack of research on the potential drawbacks of technology implementation, such as the displacement of human labour and the possibilities for technology to aggravate already-existing inequalities in the supply chain, constitutes a gap in the literature when discussing how technology implementation increases operational efficiency in supply chain management. While there is a sizable amount of study on the possible advantages of using technology in supply chain management, more research is required on the potential drawbacks and mitigation techniques. Future studies may examine the possible social and ethical repercussions of supply chain management technology adoption as well as the function of stakeholders in ensuring responsible and equitable technology usage. Researchers and practitioners may better understand the possible influence of technology on supply chain management and create methods for optimising the positive effects of technology while limiting its potential drawbacks by filling up this knowledge gap in the literature.

III. CHAPTER 3: METHODOLOGY

3.1 Research Philosophy

The interpretivism research philosophy is used in the research. It involves the researcher exploring and interpreting the subjective experiences and perspectives of the participants in the supply chain management system. The researcher seeks to understand the meaning behind the behaviours, beliefs, and attitudes of the individuals and organisations involved in the supply chain (Mishra and Alok, 2022).

3.2 Research Design

A descriptive study approach is utilised to examine the data and literature on the use of technology in supply chain management. The study aimed to explain and analyse how supply chain management is now using technology and how it affects operational effectiveness (Patel and Patel, 2019). The study's goals are stated at the outset. These goals included determining the categories of technology presently used in supply chain management and analysing the effect of technology on the effectiveness of supply chain operations (Mishra and Alok, 2022).

3.3 Data Sources

Secondary data is used for the research. Academic journals, magazines, books, government documents, business publications, and internet databases are secondary data sources (Patel and Patel, 2019).

3.4 Data Collection

To ensure the data is relevant to the study goals, it is gathered utilising a variety of search tactics, including keyword searches and database searches (Mishra and Alok, 2022). The research's keyword search strategy made collecting precise and relevant quantitative and qualitative data easier. The search focused on studies published in the last 6 years.

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3.5 Data Analysis

The research used the content analysis method to analyse the various data sources. The study is focused on analysing secondary data sources, such as academic literature, industry reports, and government publications, on finding patterns, themes, and trends connected to the use of technology in supply chain management and how it affects operational effectiveness (Mishra and Alok, 2022). The gathered data is coded to find patterns, topics, and trends relevant to the study goals. Reading and analysing the data will be part of the coding process to find recurrent terms, phrases, and ideas about using technology in supply chain management and how it affects operational effectiveness (Pandey and Pandey, 2021). The content analysis findings are analysed to make judgements and generate suggestions on the use of technology in supply chain management and its effects on operational effectiveness. Based on the trends, themes, and patterns found in the data, interpretations are made (Pandey and Pandey, 2021).

IV. CHAPTER 4: ANALYSIS

4.1 Importance of Technology used in Supply Chain Management

The research of intelligent computers that are capable of performing activities that traditionally require human intellect, such as perception, thinking, and decision-making, is the focus of the field of artificial intelligence (AI), a branch of computer science. In order to effectively estimate future demand, AI can analyse previous sales data, market trends, and other pertinent data (Di Vaio and Varriale, 2020). With this demand forecasting, businesses may optimise their inventory levels, decrease stockouts, and enhance their production planning. Similarly, a form of artificial intelligence called machine learning allows a computer programme or system to develop independently via trial and error rather than being explicitly taught how to do so (Toorajipour et al. 2021). In machine learning (ML), data or observations are used to train a computer model, which is subsequently utilised to improve the technology based on an examination of the patterns in the data (along with actual and expected results) (Modgil et al. 2022). Businesses may reduce the number of administrative tasks and free up resources for more significant and strategic endeavours by using machine learning in supply chain management. Machine learning algorithms can optimise inventory, find the best suppliers, and spot potential problems before they lead to a breakdown (Baryannis et al. 2019).

Decentralised digital ledger technology known as blockchain allows secure, accessible, and inter-party transactions without a central authority's requirement. In a blockchain, a chain of blocks is formed by individual blocks, each of which includes a record of transactions that are cryptographically connected to the one before it (Priore et al. 2019). This makes the chain very secure and hard to hack since it guarantees that once a block is put into the chain, it cannot be changed without invalidating all succeeding blocks. Hence, Blockchain technology may provide a safe means of exchanging and preserving data in the supply chain. Blockchain's decentralised structure makes it difficult for hackers to change data, lowering the possibility of fraud and cyberattacks (Ni et al. 2020). Moreover, blockchain technology may make it possible to monitor inventories in real time, improving the management of inventory levels and lowering the possibility of stockouts or overstocks (Alazab et al. 2021).

4.2 Increasing Operational Efficiency of Supply Chain using Technology

The literature explains how technology, including blockchain, artificial intelligence (AI), and machine learning (ML), might increase the operational effectiveness of the supply chain. Technology integration in supply chain management has completely changed how companies run their operations, allowing them to operate more efficiently, transparently, and with higher customer satisfaction (Blossey et al. 2019). Using IoT sensors, RFID tags, and GPS to monitor product movement enhances supply chain visibility, assists companies in streamlining their supply chain operations, and lowers out-of-stock and inventory management delays (Roeck et al. 2020). The effectiveness and productivity of supply chain operations may be increased by employing technology, AI, ML, and blockchain to automate repetitive processes like order processing, inventory management, and shipment tracking. In order to effectively estimate future demand, AI, ML, and blockchain can analyse data and patterns from past sales, market trends, and other pertinent data (Priore et al. 2019). This may help firms optimise inventory levels, decrease stockouts, and enhance production plans. Moreover, AI, ML, and blockchain may be utilised to optimise shipping routes, lower shipping costs, speed up deliveries, enhance quality control procedures, and anticipate when machinery and equipment need repair (Dash et al. 2019).

AI-based route optimization and quality control can cut defect rates by up to 90% and

transportation costs by up to 10%, respectively (Dhl.com, 2022). AI-powered predictive maintenance may help save maintenance expenses by as much as 30%. Also, a machine learning model can discover that a certain supplier has a greater failure rate than other suppliers. Businesses may lower the likelihood that quality concerns will affect their operations by utilising this knowledge to modify their sourcing methods (Ni et al. 2020). The advantages of AI and ML certainly have their advantages in increasing supply chain efficiency. However, blockchain technology can increase the network's security while providing the advantages of real-time monitoring, increased transparency, and tracing of the origin of items (Rejeb et al. 2019). Blockchain in supply chain management may increase transparency by enabling real-time visibility and tracking of the flow of items and information for all stakeholders. With more openness, it will be simpler to spot inconsistencies or abnormalities in the supply chain, which may assist in preventing fraud and lower the risk of counterfeiting (Baryannis et al. 2019).

V. CHAPTER 5: CONCLUSION

In conclusion, integrating emerging technologies such as AI and blockchain in supply chain management can benefit organisations significantly. These technologies can enhance operational efficiency, reduce costs, improve traceability, and increase security in supply chains. AI can be used for predictive analytics, demand forecasting, and process automation. At the same time, blockchain can provide a secure and transparent decentralised ledger that enables end-to-end traceability and reduces the risk of fraud and errors.

However, successfully implementing these technologies requires careful planning, investment in infrastructure, and collaboration between stakeholders in the supply chain. Organisations must identify the most suitable use cases for these technologies and ensure they align with their business objectives. They also need to address data privacy, interoperability, and standardisation issues to ensure that the technology is effectively integrated into existing systems.

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