

Evaluating the Role of IT Innovations in Enhancing Logistics and Supply Chain Management Effectiveness: A Review Paper

Atam Kumar^{1*}, Muhammad Danish²

¹Department of Mechanical, Energy and Management Engineering, University of Calabria, Rende, Cosenza, Italy

²Department of Mathematics and Informatics University of Calabria, Rende, Cosenza, Italy

DOI: [10.36348/sjet.2024.v09i07.010](https://doi.org/10.36348/sjet.2024.v09i07.010)

| Received: 18.06.2024 | Accepted: 24.07.2024 | Published: 26.07.2024

*Corresponding author: Atam Kumar

Department of Mechanical, Energy and Management Engineering, University of Calabria, Rende, Cosenza, Italy

Abstract

Supply chain management (SCM) is crucial for companies looking to enhance their business processes, with information technologies playing a significant role in revolutionizing SCM. This paper analyzes modern technologies used in SCM, focusing on logistics, information technology, and supply chain management. It explores how technology is utilized in various sectors where SCM is prevalent. Previous research demonstrates a wide array of technologies used in logistics and SCM, with this analysis highlighting a few key ones. The study reveals that new technologies greatly improve SCM by enhancing quality, efficiency, effectiveness, productivity, and reducing costs. It also investigates the diverse effects of technologies on SCM and logistics, showcasing real-world case studies of successful technology implementation. Overall, the analysis emphasizes the importance of contemporary technologies in advancing organizational progress, particularly in SCM optimization. It provides valuable insights into the benefits and practical applications of technological advancements in SCM, while also acknowledging their disruptive potential.

Keywords: Supply Chain Management, Logistics, Information Technologies, Innovation, Organizations, Impact.

Copyright © 2024 The Author(s): This is an open-access article distributed under the terms of the Creative Commons Attribution 4.0 International License (CC BY-NC 4.0) which permits unrestricted use, distribution, and reproduction in any medium for non-commercial use provided the original author and source are credited.

1. INTRODUCTION

1.1. Supply Chain

Supply chain management is one of the most essential aspects of doing business. Many people outside the instant community do not realize this, as the average consumer often only feels the impact. Remember those times when the item you wanted wasn't available at your favorite clothing store or grocery store, remember how many times you got a "good deal" at the end of the season, remember your sudden increase in gas prices due to scarcity, remember those times when your e-commerce website promised stock but couldn't send the requested product or sent you the wrong product or a recall saves you time when your custom product you are significantly delayed. All the above and several other experiences that consumers regularly go through are a direct consequence of the supply chain practices that companies follow. Unlike business-to-consumer transactions, supply chain operations have an immediate impact on business-to-business transactions. In the late 2000s, due to problems in the largely outsourced supply chain for the 787 Dreamliner, Boeing suffered significant

delays in launching new aircraft and incurred costs of more than 2 billion USD to support and accelerate the supply of components. Less than two years after delivering the first Dreamliner 787 in 2011, Boeing was ordered to stop production of the plane due to battery quality problems. In 2007, Mattel had to recall tens of millions of toys made in China, epitomizing concerns about the quality of foreign products. While some companies suffer the consequences of poor supply chain management, companies like Amazon, Walmart, and Zara consistently outperform their competitors thanks to their excellent supply chain capabilities [1].

Supply chain management (SCM) is concerned with the coordination and management of an organization's supply chain. Note the plural in "Chains": Organizations may operate multiple supply chains that work together to serve different segments. For example, in defining logistics, maintenance, repair, and overhaul (MRO) of military systems in an operational area can be managed through separate supply chains. Similarly, in industrial logistics, there may be a specific supply chain

for different combinations of markets, consumers, products, or even seasons [2].

Since Keith Oliver, a consultant at Booz Allen Hamilton, coined the term in 1982, supply chain management has evolved from a simple understanding of logistics into a three-function business enterprise, multi-functional, complex, ranging from supply and demand forecasting to distribution and beyond. Supply chain management is such a broad topic that people often come up with a different definition based on their personal

experiences. For example, supply chain management includes managing the supplier base, determining what to outsource and whom to hire, and managing relationships with different suppliers. For others, it all depends on how the different companies in the distribution channel or value chain are integrated in terms of information systems and inventory management practices. In a sense, all these definitions are like blind men defining an elephant according to its different organs. A complete definition of supply chain management can be given as follows.

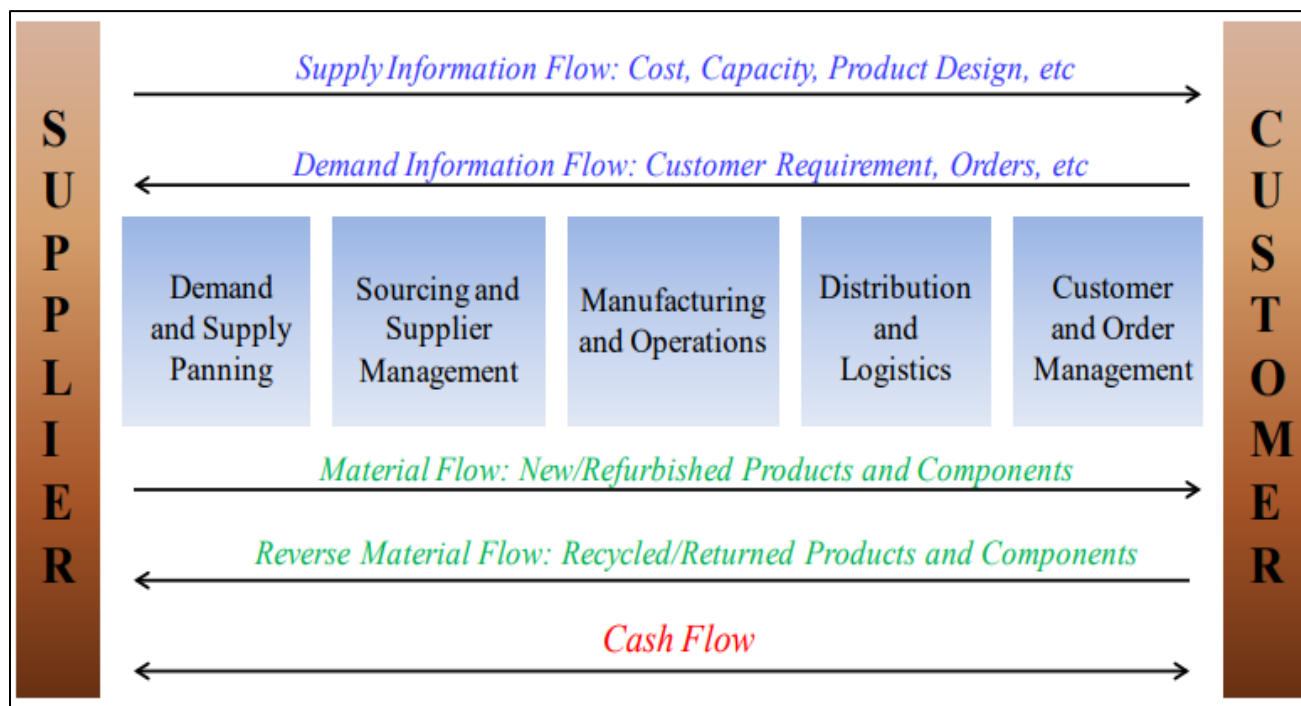


Figure 1: Supply Chain Process [1]

A supply chain is a set of entities involved in designing new products and services, sourcing raw materials, converting them into semi-finished and finished products, and delivering them to final customers. Supply chain management is the effective management of the end-to-end process from the conception of a product or service to the moment it is sold, consumed, and ultimately disposed of by the consumer. This comprehensive process includes product design, sourcing, planning, and forecasting, manufacturing, distribution, fulfilment, and after-sales support [1].

1.2. Logistics

According to a broad definition, logistics is the study within an organization of the management and implementation of activities related to the flow of tangible goods from source to point of use, consumption, or disposal to achieve the organization's goals. To achieve this goal, logistics requires the collection, integration, and processing of data from multiple sources to plan, organize, and control activities such as

processing, production, packaging, storage, and distribution.

The words “logic” and “logistics” both come from the Greek term *logos*, which means “order”. However, while the word “logic” is of direct Greek origin, the word “logistics” first entered Medieval French as “logis”, meaning “accommodation”, and then English. The origins of logistics were purely military in nature. This discipline was born from the study of methods to ensure the accurate supply to the army of food, ammunition, fuel, etc.

The importance of logistics became clear during the American War of Independence (1775–1783) when the lack of adequate supplies for the 12,000 British troops overseas during the first six years devastated morale. Of the army and contributed to their ultimate defeat. In modern times, logistics played an important role in World War II, which helped the Allied powers succeed. In modern times, the key concept in defining logistics is the supply chain, defined as the set of processes, infrastructure, equipment, and personnel that

ensure that a particular vehicle or weapon is fully operational on the battlefield [2].

1.3. Information Technology (IT)

Information technology (IT) is defined as “the science and activity of using computers and other electronic equipment to store and send information” [3].

“Many areas of public health, including vital statistics, surveys and research, surveillance, epidemiology, surveys, laboratory technology, maternal and child health, and environmental health, use information technology (IT) to achieve its goals and objectives. Informatics includes the use of computers and communications, converting data into information and knowledge [4].

“Most modern businesses rely heavily on information systems, from employee emails to database management and e-commerce websites. Hospitals must manage large patient databases. Universities have vast networks to manage. Even a small home-based cookie business needs an order-tracking system. The American Information Technology Association reports that 92% of IT professionals work for non-IT companies” [5].

Today's businesses face the disruptive forces of global competition, rapidly evolving customer needs, and the accelerating pace of technological change that is straining the ability to sense and respond. Responding to market changes becomes necessary. These skills are even more important for companies that must identify and communicate market changes and coordinate responses to these changes across the entire integrated supplier chain [6].

Significant advances in information technology have occurred across all sectors, including changes in logistics and supply chains. Rapid data transmission is a result of information technology in supply chain management, leading to increased collaboration. Information technology helps restructure the entire distribution system to achieve higher service levels, reduce inventory, and reduce supply chain costs. The evolution of IT has given businesses unprecedented opportunities to gain a competitive advantage. Therefore, IT investment is a prerequisite for any company to survive in the market. Supply chain management (SCM) involves the flow of products and information between member organizations in a supply chain. Recent developments in technology allow organizations to easily obtain information at their premises. There are three distinct benefits to developing an inter-organizational supply chain information system: cost reduction, productivity, innovation, and product/market strategy [7].

Modern supply chains and logistics face many challenges related to urban and rural demand, such as how to use competitors as collaborators, increase

visibility, and incentivize multichannel, trade-off between analytics and if/then modelling, complexity optimization, and indirect attribution capabilities. Spending, variable metrics targets, and incentives aligned to desired outcomes. Practitioners face challenges such as how to manage complexity closer to customers and how logistics operations can support them, especially how logistics managers can act as the commander of an information control tower. To address these challenges, it is necessary to design strategies and evaluate points of difference with the support of information technology (IT) [8].

IT infrastructure by itself does not differentiate a company from its competitors because IT applications are increasingly standardized. However, improved business performance and sustainable competitive performance can be achieved when IT infrastructure is used to meet customer-defined organizational needs. IT infrastructure can have a significant positive impact on a manufacturing company's supply chain efficiency when it allows the company to benefit from IT-sharing capabilities. These shared capabilities can help companies create capabilities that are unique, difficult to imitate, and non-substitutable [9].

It has been observed that there are so many problems occur in various supply chain system as forecasting means predicting future demand, increased cost, lead time increase, labour shortage, delays, poor logistics management or inspection, and quality control. Nowadays IT is the best solution for problems. This study analyses problems related in supply chain management system and logistics system, review previous studies of IT implemented system and compare its impact or effect on modern era.

2. LITERATURE REVIEW

The electronics industry faces rapid market changes, fierce competition, rapid technological innovation, and growing environmental awareness among customers. Therefore, there is an essential need for companies to develop the necessary agility to survive in this competitive environment. Flexibility exists in supply chain networks and can help companies gain a competitive advantage. Previous studies have emphasized that supply chain agility (SCA) focuses on promoting innovation, flexibility, and speed, which subsequently reduces production costs [10].

Faced with increasing global competition, manufacturers are looking to develop sustainable competitive performance to improve their competitive position. Competitive performance can come from many different sources, such as product and service differentiation based on price, quality, or service, but it is most sustainable when it is difficult to imitate. Computer communication represents a potential source of difference. In a company with competitive performance driven by IT, IT systems ensure fast

communication both internally and with external suppliers [11].

In general, technology itself is not a rare or heterogeneous resource. However, computer-sharing capabilities, in the way they are implemented, can be unique and difficult to imitate. These two aspects of IT shareability have been used to explain how companies can use IT infrastructure deployment to effectively improve organizational capabilities. The first dimension called the computer scale, represents the degree to which a manufacturing company can provide a transparent, accurate, and consistent flow of information within the company and with suppliers. The second aspect, called computer coverage, is the extent to which a company's computer network connects and supports various functions at different levels within the company, connecting the company to its suppliers. Provides and supports the relationship between the company and its suppliers [12].

In this business environment, organizational processes and product innovation are major business challenges and critical to business success. Innovation is defined as "the adoption of an internally created or acquired device, system, policy, program, process, product or service that is new to the adopting organization. Creating and maintaining a competitive advantage has become a matter of continuous innovation and business innovation. In the past, companies focused on reducing costs and improving quality to gain a competitive advantage. But today, "companies must be able to innovate at the edge of the world" and create and commercialize new lines of products and processes that push technological boundaries, advancing rapidly as their competitors catch up [13].

Information systems, by informing managers about agents' actions, can reduce agents' opportunism and affect the bounded rationality of participants by reducing Contract and supervision costs. IT can reduce coordination costs and reduce transaction risks. It aims to create a less risky relationship between parties by promoting information exchange or by replacing investments in highly specific assets with investments in IT/IS. Imperfect information, an essential aspect of TCE, leaves open risk. Opportunistic behaviour on the part of suppliers. With transparent systems, IT has the potential to reduce imperfect information and uncertainty and has a protective function by reducing information asymmetry and developing group rules among partners. Empirical evidence for the above arguments about the role of IT integration in reducing transaction costs was supported by a study in which B2B e-commerce systems supporting inter-organizational systems were discovered to help reduce transaction costs [14].

An external focus in the use of IT is a critical success factor in responding to market changes and new opportunities. However, this type of usage requires a

more complex set of organizational and management capabilities, which is necessary when IT is used only to automate business processes and improve internal efficiency. The environment is associated with the rules of business response in terms of organizational structure and capacity. According to the stochastic and evolutionary perspectives, firms that deviate from these "optimal" responses perform worse and are likely to exit the industry in the long run. In principle, because investments in IT can enable easy adaptation to unstable market demands, changing customer needs, and new market opportunities, dynamic, resource-rich environments will require greater IT deployment to support external IT capabilities. In contrast, in resource-scarce environments, companies are expected to derive greater economic value from developing internally focused IT capabilities, given their importance in enhancing efficiency [15].

Supply chain flexibility is defined as the ability of target companies to match demand with supply in collaboration with upstream and downstream members of the supply chain. The company's innovation capacity role, in addition to producing products and services, is also to promote technology and information. Little attention is paid to innovation capabilities in the supply chain management process. Innovation capacity is the means of accepting or applying innovation concepts to the organization. It is the process of developing a new concept and is used to commercialize products and bring these innovations to market. Innovation ability has a positive impact related to competitive advantage, in which innovation ability can be measured from the aspects of product innovation, process innovation, service innovation, and organizational innovation. New. Regalia said there are four innovations, which are market innovation, radical innovation, incremental innovation, and technological substitution. Meanwhile, competitive advantage includes superior aspects of quantity and quality of financial, physical, and human resources as well as superior management and technical capabilities and favourable location. Stoic said the product design innovation market involves significant changes in key organizational elements. Organizational innovation is the set of new ideas, methods, and organizational goals that support success in the marketplace. Organizational innovation is a key factor considered to achieve competitive advantage and ensure long-term success in market competition. Furthermore, innovation is social change. Organizations with innovation capabilities can respond to environmental changes faster than innovative organizations and thus have high performance. In the age of data and IT developments, companies must innovate and interact with the market. Dimensions of organizational innovation include product innovation, process innovation, and administrative innovation. Anna V and Anatoly K argue that there are five dimensions of innovation capacity, which are financial, human, technological, information, and organizational [16].

3. Role of IT in Logistics and Supply Chain Management.

The role of IT in supply chain management is very important. There are many applications of information technology in supply chain management. It provides tools to gather relevant information and break it down for proper analysis. In addition to helping implement it to achieve optimal supply chain performance. Data is essential for supply chain operations. Mainly because it provides a basis for supply chain managers to make decisions.

So, real-time information is the key to good supply chain management. With deep insights into the different stages of the supply chain, decision-makers can strategize, manage, and align processes to achieve sourcing, inventory goals, production, etc. These are all points that show us the importance of IT in the supply chain. Management and use of IT in supply chain management.

3.1. Integrated and coordinated supply chain

Supply chains can operate effectively when they are well-integrated and coordinated. It accomplishes this important task by integrating multiple technologies and combining them to optimize the supply chain. These technologies make data collection possible, easier, and much more accurate. Ultimately, this enables accurate and detailed data analysis to make sound business decisions.

3.2. Increase productivity.

Smooth information flow, new technology, and effective communication increase the productivity of all

units in the supply chain. It's like an introduction to the product movement. In addition, the IT department establishes a link that continuously transmits the necessary information.

3.3. Cost Reduction

It allows for optimal use of assets and resources. Past data is used to study trends. And technology is used to analyse it to fine-tune performance. When resources are used optimally, they help reduce costs. The role of IT in SCM is becoming more and more important as it motivates all parties to use their respective resources in the most cost-effective way possible. When IT is used properly, overall costs are significantly reduced.

3.4. Product improvement

Furthermore, IT includes tools and applications that can be used to achieve early awareness. In a market where customers always want something new, the product will have to evolve, or it will no longer be in demand. So, to stay in business, you need to introduce product improvements and innovations as soon as possible.

3.5. Supply chain visibility

Therefore, the information that builds the entire supply chain is visible to supply chain managers. The way information is passed from one employee to another and its impact on others are used by managers to make strategic decisions [16].

4. Technologies used in supply chain and logistics systems

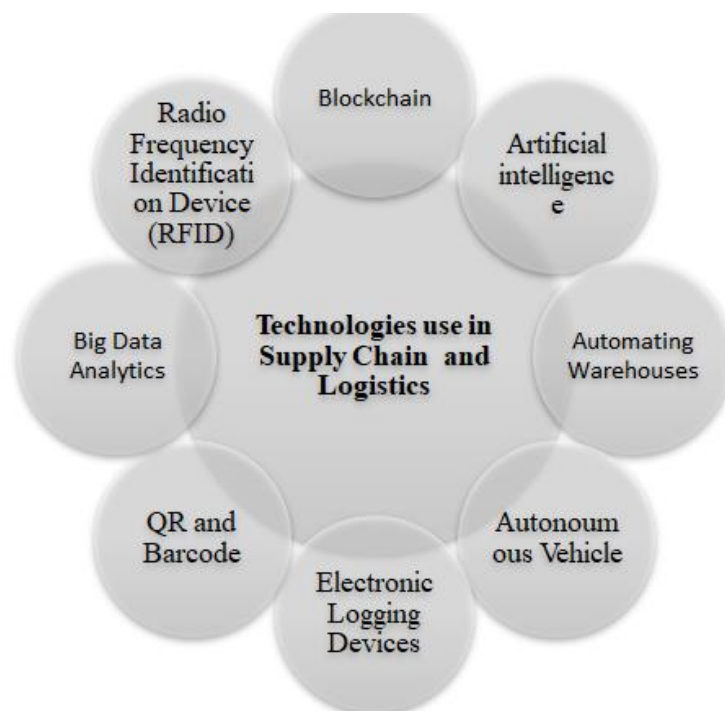


Figure 2: Technologies used in Supply Chain and Logistics [17]

5. Impact of Technologies on Supply Chain Management and Logistics.

5.1. Impact of Blockchain Technology on Supply Chain Management and Logistics.

International Business Machines (IBM) defines Blockchain Technology (BCT) as an immutable, shared ledger that facilitates the process of recording transactions and tracking assets within a business network, which can be visible or invisible to reduce risk and minimize costs. BCT provides instant, shared, and fully transparent information to authorized networks that can track production, accounts, orders, and payment statuses with end-to-end details. According to Brook Banks and Parry (2022), Blockchain-based platforms provide shared trust, reduce data duplication, and improve supply chain visibility. The key elements of BCT are immutable records, smart contracts, and data management using distributed technology [18].

The connection of individual blocks to these pointers creates a chain of blocks called a Blockchain. The main benefits of Blockchain are decentralization, cost reduction, scalability, or making transactions efficient, and distributed rather than centralized. According to Baja, technology, IT systems, and operational efficiency are the most important factors in BCT. Blockchain security relies on digital identity and cryptography. BCT can contribute to important supply chain goals. According to Fernandez, the benefits of Blockchain-based supply chains are significantly greater than conventional supply chains. Members of the supply chain collaborate to add value to the material flow with the essential goal of meeting the needs of the end customer. According to Kouhizadeh, the four main capabilities of Blockchain are transparency and traceability, reliability and security, smart contracts, and incentives. Different people view supply chains differently [18].

Some of the positive impacts of BCT are discussed as follows:

- By implementing smart contracts, BCT enables real-time order settlement and automation of production tasks. Additionally, BCT ensures that ripple effects in OSCM are minimized, thereby minimizing disruptions caused by model changes.
- BCT services ensure data and resource allocation, system security and confidentiality, confidentiality, authentication, and integrity. BCT is significantly more secure than conventional IoT systems or conventional security services thanks to its ability to improve cyber security and deliver superior performance.
- BCT enables efficient business process management through smart contracts by combining the control flow and business logic of business activities across organizations. Blockchain can also be integrated with smart

contracts for hyper-connected logistics, where the mechanisms are supported by triggers and act as a connection between business applications and the Blockchain.

- Using digitalization and smart contracts to ensure collaboration between all stakeholders, integrating BCT will transform OSCM's organizational structure.
- By integrating BCT with SC, Blockchain improves quality, productivity, and cycle time, creates new business opportunities, and drives product differentiation. There have been many studies on the effectiveness of using BCT to regulate prices and destroy products.
- Using Blockchain in OSCM not only improves efficiency and reduces costs, but also improves interaction between all participants. In addition, it increases trust and simplifies related business procedures.
- BCT drives supply chain resilience by minimizing the impact of disruptions using a proactive and preventative approach to risk management while providing multi-layered protection for OSCM networks. The decentralized structure of Blockchain facilitates the identification of network and organizational risks associated with each OSCM function.
- By enabling process automation, eliminating the middleman, and enabling real-time tracking through data management, traceability, and privacy approaches, all this [18].

5.2. Impact of AI on Supply Chain Management and Logistics

AI is having a huge impact on supply chain management. Logistics companies that manage supply chains can benefit from AI's ability to monitor freight movements at scale and predict shipping needs. With the help of AI, supply chain managers now get a clearer picture of the entire system, make smarter decisions, and provide more attentive customer service. The impact of artificial intelligence on supply chain management performance. And knowledge of supply chain management. The components of an expert system are described by Kodiak (2019) as: Knowledge reorientation, which is where knowledge is framed, interface engine, which describes the knowledge acquisition and control strategy, allows the system to collect data and knowledge aims to solve supply chain management problems. AI is increasingly being applied to supply chain management to improve performance from an Agile and Lean perspective. Many companies are investing in digital solutions to optimize their supply chain operations. Figure 3 illustrates the global adoption rate of AI in manufacturing and supply chain companies. The literature has shown that AI can give businesses the ability to respond quickly to changes in demand, reduce waste, and improve collaboration and customer satisfaction [19].

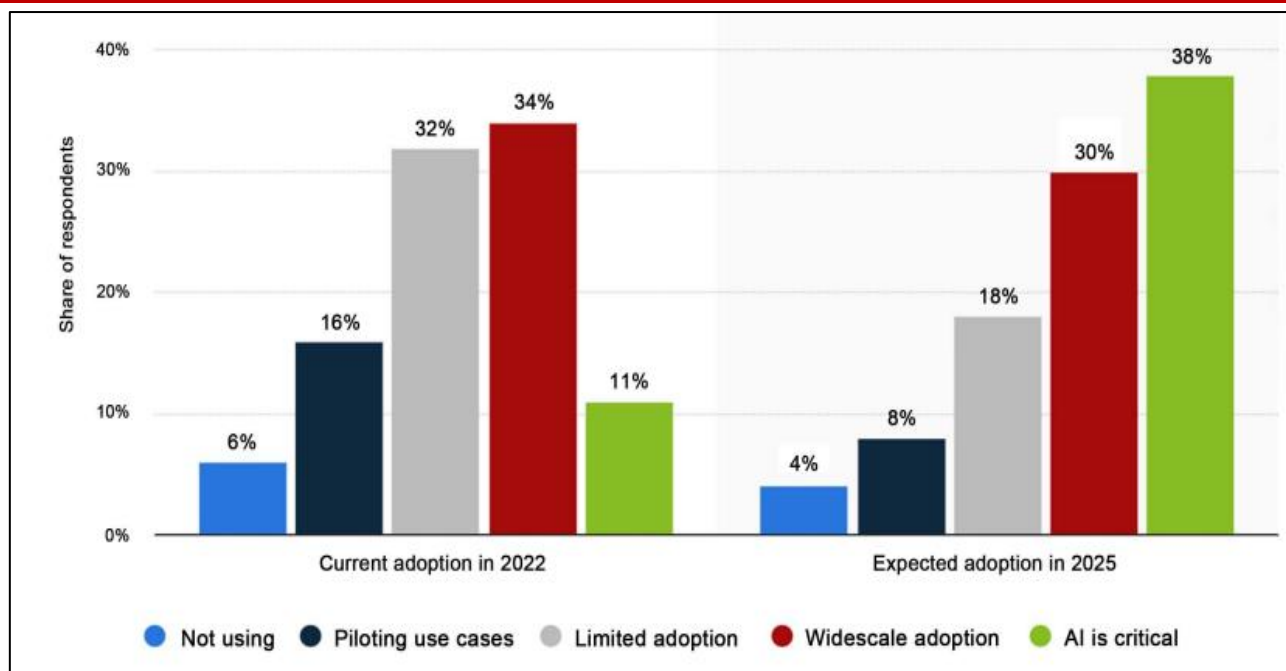


Figure 3: Global AI adoption rate in supply chain and manufacturing business (2022 and 2025) [19]

5.3. Impact of Automating Warehouse on Supply Chain Management and Logistics.

Warehouse technology and automated systems can help solve warehouse and supply chain problems cost-effectively. The right technologies can increase efficiency by improving inventory control and picking accuracy, warehouse flexibility, responsiveness, and safety and security. By combining different technologies, items can be easily moved around the warehouse and stored in their respective locations. We'll also look at some current and emerging technologies and how they can improve your inventory planning and optimization strategy [20].

5.4. Warehouse Management Systems (WMS)

The most resilient supply chains use systems that can process big data and provide advanced analytics and real-time insights. Radio-frequency identification (RFID)--based warehouse management systems can help you collect, transfer, verify, and update bulk data about the location of your goods. It operates in real-time from ingestion to dispatch and delivery, reducing labour intensity and scanning errors. Automating the warehouse management process can eliminate the need for manual inventory tracking. Improving inventory management processes can also help make the most of storage space by tracking the flow of goods through the warehouse. Combining big data, advanced analytics, and real-time insights with a modern ERP system can help you optimize your supply chain and improve its resilience [20].

5.4.1. Automated Guided Vehicles

Automated guided vehicles (AGVs), such as smart forklifts and pallet carts, are increasingly used to move inventory around warehouses. They travel

digitally, loading and unloading goods without the need for human drivers.

Depending on your warehouse and ordering process, a mix of vehicles can support your warehouse team [20].

5.5. Impact of Bar Code and QR Code on SCM

A barcode is a series of parallel lines of varying thickness and space between them. These bars are nothing more than Information elements in an encrypted form that can be read by a scanner. Information printed in bar form includes code, country code, manufacturer name, product details, production date, material content, etc. The detailed information is used on the user side for inventory management. THE Barcodes are used in many industries such as the pharmaceutical industry, large shopping malls, consumer goods, electricity, manufacturing, etc [21].

The Bar Coding Offers the Following Advantages:

- Easy identification of inventory/stock items during storage, pickup, inspection, and dispatch.
- Reduce paperwork/documentation and processing time leading.
- Reduce human error.
- Increases logistics system productivity through speed, accuracy, and reliability [21].

5.5.1. Impact of Bar Code Technology on Operations of Logistics and Supply Chain Management

Supplier sourcing materials are assigned a bar the code contains information about the item name and batch number, production date, order number, serial number, etc. The information contained in a barcode

helps with the identification and tracking of ingredients. The information decoded by the scanner will be stored immediately in a central computer allowing real-time updates of inventory records [21].

Processing- During the order processing the bar code will help in keeping the identification of items based on their date of entry into the warehouse or store. This will ease material storage and dispatch [21].

Production- During the production process the identification of in-process and finished items becomes easier due to bar coding. The various batches at different stages of production can be easily tracked [21].

Distribution- During distribution, the barcode helps in identifying and tracking the transit of finished goods to the customers [21].

5.6. Radio Frequency Identification (RFID)

RFID is automatic identification and data capture (AIDC). RFID-based systems enable contactless reading and are effective in manufacturing as well as other environments where barcodes cannot exist. This system is used as an alternative to barcodes to transmit inventory data to readers via radio waves. RFID wireless system in which information is exchanged between the tagged object and the reader [21].

An RFID System Is Comprised of the Following Components as Mentioned Below,

- One or more radio frequency tags (RFTs), including semiconductor chips and antennas.
- One or more read/write devices are also called readers.
- Two or more antennas, one on the tag and one on the reader.
- Application software and host computer system [21].

5.6.1. RFID has a Significant Impact on the Logistics and Supply Chain of Many Sectors

Increases manufacturers' ability to easily manage inventory levels. Enhance complex distribution systems for National Defence activities. Enhance the Indian Postal Service's sophisticated tracking and delivery operations. Enhance tracking, logistics, and planning in the manufacturing industry. And deploy automatic toll collection on the road network [21].

5.7. Impact of Big Data on Supply Chain Management.

Big data is transforming supply chain management by providing insights that enable better decision-making and improved operational optimization. With the increasing availability of data and technological advances, supply chain managers can leverage big data to gain a competitive advantage in the marketplace.

Using big data Supply Chain Managers can:

Improve demand forecasting capabilities. Optimize production planning and scheduling. Increase transportation efficiency. Reduce supply chain risk [22].

Big data analytics facilitates collaboration between different stakeholders in the supply chain, including suppliers, manufacturers, distributors, and retailers. By sharing data and relevant information, companies can improve coordination, synchronize production schedules, and optimize inventory levels [23].

6. Case Studies

6.1. Case Study of Lenovo by Using Blockchain Technology

Communication Verify and record activities and transactions and perform intelligent data collection and processing purchasing as well as implementation, thereby improving the service capacity of the supply chain. The present study examines Lenovo's use of Blockchain technology to enhance supply chain management and proposes a conceptual model for a Blockchain-based approach. We chose Lenovo as a case study because it is a global leader company recognized for its supply chain excellence. Lenovo has established strong relationships with upstream and downstream partners, and there is no doubt that its supply chain technology deployment strategy and supply chain management provide top advice for various industries [24].

6.1.1. Background Information

Lenovo operates in 180 countries and regions and operates 35 factories worldwide. Lenovo sets up a complex supply chain network. For example, LCFC Electronic Technology Co. (Hefei), company the world's largest personal computer (PC) factory, handles 30,000 rolls of electronic components Raw materials go through a fully automated warehouse system every day and transfer more than 2000 types of raw materials every four hours, which means any potential problems in production of spare parts can disrupt the supply chain. LCFC factory (Hefei) is actively developing products of the fourth industrial revolution, such as intelligent production planning, joint production planning, Blockchain-based supply chain collaboration, and more Innovative applications, significantly improving production efficiency. At the beginning of 2023, LCFC Factory (Hefei) was successfully selected for the list of "top factories" that represent the highest level of global smart manufacturing. Previously, to ensure the stable operation of the entire supply chain, Lenovo worked together with its suppliers and equipment manufacturers and had to assign large numbers of workers to complex tasks, Time-consuming tasks include checking accounts and tracking order statuses. Since 2017, Lenovo has applied Blockchain technology into the supply chain by proposing a supply chain integration model chain and Blockchain (hereinafter referred to as the dual chain

integration model. It applies a server operating model to integrate information flow, logistics, and flows capital in its supply chain, ensuring greater transparency in all production activities stage. After 5 years of development,

Lenovo has made outstanding progress in research and development by Applying the combination of Blockchain and supply chain (see Table 1) [24].

Table 1: Lenovo's practical exploration of the Blockchain application [24]

Step in the Process	Main Achievement
Technical preparation	From 2016 to 2017, Lenovo began to conduct technical research on blockchain, exploring the landing direction and application direction, mainly focusing on the application in the financial industry at the beginning
The "dual-chain integration" model is proposed	In 2017, a "dual-chain integration" model was proposed based on the similarity between supply chain structure and blockchain structure.
Small-scale application in the server business	In 2018, Lenovo began to carry out a small-scale application in the server business, using blockchain technology to establish a trusted sharing mechanism among Lenovo, foundries, and suppliers
Summarize experience and try to establish industry standards	Released "Lenovo Blockchain Technology White Paper" in 2018, "Lenovo blockchain white paper supply chain solution" in 2019, and "Blockchain supply chain Collaborative Application White Paper" in 2020

It addresses the challenges that traditional supply chain operations face, such as inefficiencies, lack of data transparency, and poor traceability. As a result, it significantly improves the operational efficiency of companies participating in the supply chain and ensures effective information sharing. After reviewing the development of Blockchain technology and related literature on the application of Blockchain technology in the field of supply chain management, we found that there is a lack of Blockchain applications in related fields focusing on focusing on improving supply chain collaboration efficiency. By interviewing key business and technical personnel, we explored the challenges Lenovo faces in its business operations and supply chain management related to applying Blockchain technology to solve related issues. To help other companies in the industry better learn from Lenovo's practices, we have summarized and summarized Lenovo's technical solutions into the data layer, contract layer, and application layer, and explained the content and functions that need to be implemented in each layer form a three-layer architectural model of a supply chain information system based on Blockchain technology.

The conceptual model proposed in this article focuses on the possibility of developing Blockchain technology applications from the perspective of supply chain collaboration and provides basic direction and content that needs to be considered for it to be usable. It is worth emphasizing that our case study primarily examines collaboration issues in the context of Lenovo's operations, focusing solely on the Blockchain mechanism rather than the characteristics of the IT industry. However, Blockchain technology still faces some challenges in supply chain collaboration, which will be gradually resolved in future research and practice.

First, data privacy protection must be improved. However, sharing real business data across the supply chain has value in the realm of supply chain collaboration.

Second, the adoption of Blockchain-based supply chain collaboration needs to be further encouraged. Compared with finance, certificate of deposit, pure tracing, and other application system 2023, 11, 299 21 of 25, Blockchain-based application in supply chain collaboration requires complex advanced technologies. However, few companies are willing or willing to adopt this application, so effective promotion among companies in the upstream and downstream supply chains still needs to be achieved. Fourth, the application standards of related technologies need to be clarified, because the international community currently attaches great importance to Blockchain standardization. However, regarding application scenarios in supply chain collaboration, existing research on applicable standards for related technologies is still incomplete. Therefore, in the future, typical innovative applications for promoting Blockchain on a large scale can be considered and the logic of Blockchain-based supply chain scenarios can be further clarified [24].

6.2. Case Study of Artificial Intelligence (AI)

Logistics companies that manage supply chains can benefit from AI's ability to monitor freight movements at scale and predict shipping needs. Since the beginning of 2010, AI applications have exploded in popularity, creating both enthusiasm and anxiety about the future of the world of work and business administration. The supply chain literature seems to be catching up with some recent efforts to integrate modern AI methods into its core research, even as companies

adopt AI and invest in AI solutions to improve their end-to-end supply chain operations. AI is defined as a computer network that can simulate human intelligence while making decisions about how to approach a business problem. AI helps design thinking in business systems and learns from data to gain insights without human intervention. With the help of AI, organizations can identify weaknesses in their supply chain management and allocate resources accordingly. By quickly tapping into customer expectations, analysing the market, using failure modes, optimizing internal and external supply chains, and encouraging a more innovative workforce through automating routine tasks, AI has the potential to help businesses create the best products possible. Most supply chains have faced new levels of resilience during the COVID-19 crisis as they face the challenge of managing increasingly complex tasks. The components of an expert system are described by Kodiak (2019) as Knowledge reorientation, which is where knowledge is framed, the interface engine describes the knowledge acquisition and control strategy, allows the system to collect data and knowledge aims to solve supply chain management problems. Rule-based, fuzzy, framework-based, and hybrid methods are some examples of expert system approaches that can be used in combination with each other to achieve optimal results from AI in supply chain management. According to Jakupović's (2014) research, expert systems work very well in domains where human intelligence can be formally organized. In recent years, there has been growing interest in applying AI techniques to the modelling and simulation of complex systems in supply chain management. Agent-based computational techniques can be a valuable tool for describing the interactions of system components and analysing performance in real-world supply chain management scenarios [25].

6.3. Case Study Regards Electronic Lodging Devices.

Initially, the most obvious impact was on price. Without the ability to circumvent the law, carriers cannot squeeze more productivity out of drivers. It has become more difficult for carriers to carry out similar transport operations in less time. Direct impact on exchange rates and prices. Another impact is on capacity. This new mandate may have weeded out non-compliant businesses. Additionally, drivers are creatures of habit, so these new rules and regulations may cause motorists to complain. The new regulations may have prompted some drivers to explore new and different employment opportunities. This mandate could cause problems for carriers in an already difficult driver recruitment and retention market. In the new ELD environment, driver wait and hold times have a direct impact on supply chain performance and on-time performance. The days of having to wait 3-4 hours to charge are long gone. If shippers want their goods to arrive on time, they need to adjust their shipping method. Keeping drivers at the docks for hours reduces their productivity and therefore affects their punctuality. Shippers will need to respond

and manage driver loading times appropriately. Arresting drivers will remain a major problem. Drivers are paid to drive, and if time in port is wasted, carriers rush to charge for time spent in detention. In short, this mandate is good for the industry. Awareness of the changes will help shippers and carriers respond to this new environment together. Shippers should pay attention to the ELD mandate and respond to this new shipping environment. Here are some simple ways to collaborate and adapt to your carrier base and shipping methods. Discuss your service provider's compliance with the mandate and identify potential impacts on your business. Discuss transit times on rails. Has your carrier been traveling for hours on one of your shipping routes? If so, discuss plans to restructure lane zoning and/or planning to meet your transportation parameters. Work closely with your carrier partners and internal teams. Remember that being prepared and ready to load your shipment will help your carrier meet transit times and reduce potential detention times. Work with your internal shipping team to become a "preferred shipper." Carriers prefer to work with shippers who are organized and efficient. Again, the driver is paid to drive. These opportunities will also reduce wait times and therefore maximize your driving hours in the lane. If you are aware of and adapt to this new environment, you can manage these impacts and position your supply chain for success [26].

6.4. Case study of Warehouse Management System.

A warehouse is a facility in the supply chain to consolidate products to reduce transportation costs, achieve economies of scale in manufacturing or purchasing, or provide value-added and shortened processes. Warehouses are facing a variety of challenges: increasingly integrated and shorter supply chains, globalized operations, more demanding customers, and ongoing technological changes. A warehouse management system or WMS is primarily intended to control the movement and storage of materials in a warehouse and process related transactions including shipping, receiving, putting away, and picking. Warehouse management system 'WMS' is a database-based computer application designed to improve warehouse efficiency by directing cuts and maintaining accurate inventory by recording warehouse transactions. The system also directs and optimizes inventory based on real-time information about trash usage status. They often use automatic identification data collection (AIDC) technology, such as barcode scanners, mobile computers, wireless local area networks (LANs), and Radio Frequency Identification capabilities (RFID) to effectively monitor product flow. Once data is collected, there is real-time mass synchronization or wireless transmission to a central database. The database can then provide useful reports on the status of goods in the warehouse. The main function of a warehouse control system is to receive information from a higher-level host system, usually a warehouse management system, and translate it for daily operations. A warehouse control system is typically the interface used to manage

processes, people, and equipment at the operational level [27].

RFID technology is applied to support the collection and sharing of data in the warehouse. Implementing RFID technology requires a thorough analysis of the costs and benefits of implementation. RFID can improve the self-checkout process in retail stores, so it can reduce inventory costs through more efficient shelf replenishment. RFID technology can support business process redesign; improve data quality; real-time data collection; and synchronize and share information between actors in the supply chain. Implementing RFID can also provide additional benefits such as reducing losses due to shoplifting and increasing the use of point-of-sale applications.

This case study conducted at India's largest retail company, which has developed expertise in supply chain management of consumer products such as fashion, food, and general merchandise. The company operates from 60 strategically located centres, serving over 2,600 stores spread across India. Of the three warehouses studied, one had an automated WMS and the other two were managed manually and had a high cycle time of 773 minutes. The retail chain has three other warehouses serving a total of 14 stores across South India. With the company planning to add more stores and establish a centralized warehouse, the chain will become less efficient. To improve efficiency, a study was conducted to analyse the impact of implementing WMS

in these warehouses. The research begins by understanding the current state of warehouse operations. Value stream mapping was used for this purpose. Value stream mapping is the simple process of directly observing the flow of information and documents as they occur and summarizing them visually. The value chain includes all the steps, value-added and non-value-added, required to move a product or service through the stages of the process. Next, a future system map (if needed) is developed to design a lean process through the elimination of root causes of waste and process improvements, all of which led to deployment. At these warehouses, goods are received in large quantities and stacked on shelves. Even though scanners are used to receive goods in these warehouses, they are still considered manual warehouses. Many sellers who supply warehouses still send goods directly to stores and then to warehouses due to infrastructure and capacity limitations. The current process has a cycle time of 773 minutes, of which 537 minutes are non-value added. Because it follows a continuous rotation process, goods must be stored on the floor until dispatched. The amount of goods that can be stored directly corresponds to the total floor space available. Minimal racking was available to store "return to vendor goods". With limited available infrastructure, it was difficult to track and retrieve these items. As shown on the map, the processing cycle time is reduced to 236 minutes. On-value-added time was reduced to 95 minutes. The process-wise improvements are shown in Table 2.

Table 2: Performance Improvement at Warehouse after WMS Implementation [27]

Process	Time Saving per Order (in minutes)	Process Improvement (%)
Receiving	159	68
Put-Away	14	36.84
Picking	49	77.78
Packaging	35	68.62
Dispatch	424	94.2

6.5. QR codes

One of the key benefits of using QR codes for inventory management is the ability to track inventory in real time codes can be used to track the movement of products in the warehouse, from receipt to shipping. As products move through the warehouse, QR codes can be scanned to update location and quantity.

Three Ways You Can Use QR Codes in Your Warehouse

Receiving:

One of the most important stages of inventory management is the receiving process. This is where products are received and checked for accuracy and quality. By using QR codes, the receiving process can be streamlined, saving time, and reducing the risk of errors.

When products are received, they can be tagged with a QR code that includes information about the product, such as name, SKU, and quantity. QR codes can

be scanned to update inventory systems and track product movements in the warehouse. This process can be more streamlined by using a mobile app that scans QR codes and updates the inventory system in real-time.

Picking and Packing:

Pick and pack is another important step in warehouse inventory management. This is where products are picked from the warehouse and packaged for shipping. By using QR codes, the picking and packing process can be made more efficient and accurate.

Each product can be labelled with a QR code that includes order information, such as the order number and quantity of product needed. Warehouse staff can scan QR codes to check products and update the inventory system. This process can be more streamlined by using a mobile app that scans QR codes and provides picking and packing instructions to warehouse staff.

Shipping:

Shipping is the final step in inventory management. This is where products are packaged and shipped to customers. By using QR codes, the shipping process can be made more efficient and accurate.

Each product can be labelled with a QR code that includes shipping information, such as delivery address and service provider. When products are shipped, QR codes can be scanned to update inventory systems and track product movements. This process can be more streamlined by using a mobile app that scans QR codes and generates shipping labels and delivery slips [28].

6.6. Global Positioning System (GPS)

The logistics and supply chain sectors are an essential part of the global economy. They involve planning, managing, and executing the movement of goods and resources from one point to another. These industries are famous for their complexity, resulting from the different players, the many modes of transport used, and the need for on-time delivery.

In recent years, GPS tracking devices have been a game changer in the logistics and supply chain industry. These devices provide real-time shipment tracking, monitoring, and analytics, delivering greater efficiency, cost savings, and improved customer satisfaction.

6.6.1. The Impact of GPS Trackers on the Logistics and Supply Chain Industries

GPS tracking devices provide real-time tracking and monitoring of shipments, vehicles, and assets, allowing businesses to manage their supply chains more effectively and efficiently. By tracking shipments and vehicles in real-time, businesses can gain valuable insights into their operations, including the location and condition of goods, fleet performance, and potential delivery problems or delays. Using real-time tracking data, businesses can optimize their routes and schedules to minimize idle time and reduce fuel consumption, resulting in significant savings. Additionally, GPS tracking devices can help businesses reduce the risk of theft or loss by providing alerts and notifications if assets or shipments deviate from the expected route or location. With real-time tracking and monitoring, businesses can provide customers with accurate, up-to-date information about their shipments, including estimated delivery times as well as any delays or problems. In addition to these benefits, GPS tracking devices can also help businesses comply with regulatory requirements and improve their environmental sustainability. By optimizing their routes and schedules, businesses can reduce carbon emissions and improve environmental performance. Additionally, GPS tracking devices can help businesses comply with regulations related to driver safety and vehicle maintenance by providing data on driving behaviour, vehicle performance, and vehicle needs.

Future of GPS trackers in logistics and supply chain

The future of GPS trackers in logistics and supply chains looks promising with the continuous advancements in technology. Here are some potential developments to look out for:

Integration with other technology: GPS trackers will likely be integrated with other technologies such as sensors, IoT devices, and machine learning algorithms. This integration will provide more accurate, real-time data allowing businesses to make informed decisions.

Artificial intelligence: Artificial intelligence (AI) is becoming increasingly popular in the logistics industry, and GPS tracking devices are no exception. AI algorithms will enable businesses to analyse large amounts of data collected by GPS tracking devices, helping to optimize delivery routes, improve supply chain visibility, and reduce costs.

Predictive analytics: Predictive analytics will be a game changer in the logistics sector. GPS trackers can provide real-time data on shipment location, temperature, and other important factors. By analysing this data, businesses can predict potential delivery delays, identify shipping behaviour patterns, and optimize supply chain operations.

Blockchain Technology: The use of Blockchain technology in supply chains and logistics is growing in popularity, and GPS tracking devices can play an important role in this regard. By combining GPS trackers with Blockchain technology, businesses can create a secure, transparent, and tamper-proof supply chain network.

Autonomous technology: GPS tracking devices are already being used in autonomous vehicles, but this trend is expected to continue. With the rise of autonomous trucks and delivery drones, GPS tracking devices will play a vital role in ensuring these vehicles reach their destinations safely and efficiently [28].

7. CONCLUSION

From this review study it has been observed that Logistics and supply chain management have been significantly impacted by technology, enabling organizations to boost productivity, reduce costs, and boost customer happiness. It has given businesses using cutting-edge technology a competitive advantage. Additionally, it has served as a platform for the creation of innovative products and services. Automation, AI, IoT, and Blockchain and other technologies that are causing change in the market. The adoption and use of technology in the supply chain and logistics sectors will keep growing. These recently described technologies are currently accessible and will significantly enhance your supply chain. Future developments that will impact supply chain management and logistics are likely to increase as technology develops.

8. Limitation

This study just overview of previous studies and focuses on which technologies are used in supply chain and logistics and what is the impact of those. In this study no authentic data means new data has been taken from any service or manufacturing system but it has been analysed from the previous studies or case studies data. If this study takes data from any supply chain system or logistics, then there may be other results, but previous studies suggest these results.

9. Future Recommendation

It suggests that the next researcher go to various supply chain and logistics firms and find out technologies used there and collect the data according to their usage and then compare the results of all firms' data. After doing a comparison, decide what is impact of technologies in the supply chain and logistics system.

REFERENCES

- Lu, L. X., & Swaminathan, J. M. (2015). "Supply Chain Management," in *International Encyclopedia of the Social & Behavioral Sciences: Second Edition*, Elsevier Inc., 709-713. doi: 10.1016/B978-0-08-097086-8.73032-7.
- Gianpaolo, G., Laporte, G., & Roberto, M. (2004). Introduction to logistics systems planning and control. *J Wiley*, 2004.
- "'IT Definition' Cambridge International Dictionary of English <<https://dictionary.cambridge.org/dictionary/english/information-technology>>."
- "'Information Technology', encyclopedia.com [online] < <http://www.encyclopedia.com/science-and-technology/computers-and-electrical-engineering/computers-and-computing/information-1>>."
- "ROOS, DAVE, 'How Information Technology Works' [Online] <<https://money.howstuffworks.com/how-information-technology-works.htm>>."
- Degroote, S. E., & Marx, T. G. (2013). The impact of IT on supply chain agility and firm performance: An empirical investigation. *Int J Inf Manage*, 33(6), 909–916. doi: 10.1016/j.ijinfomgt.2013.09.001.
- "<https://transport-logistics.ciotechoutlook.com/cioviewpoint/impact-of-information-technology-in-the-field-of-logistics-and-supply-chain-management--nid-3774-cid-94.html>."
- Gunasekaran, A., Subramanian, N., & Papadopoulos, T. (2017). Information technology for competitive advantage within logistics and supply chains: A review. *Transp Res E Logist Transp Rev*, 99, 14-33. doi: 10.1016/j.tre.2016.12.008.
- Jin, Y., Vonderembse, M., Ragu-Nathan, T. S., & Smith, J. T. (2014). Exploring relationships among IT-enabled sharing capability, supply chain flexibility, and competitive performance. *Int J Prod Econ*, 153, 24-34. doi: 10.1016/j.ijpe.2014.03.016.
- Wu, K. J., Tseng, M. L., Chiu, A. S. F., & Lim, M. K. (2017). Achieving competitive advantage through supply chain agility under uncertainty: A novel multi-criteria decision-making structure. *Int J Prod Econ*, 190, 96–107. doi: 10.1016/j.ijpe.2016.08.027.
- Jin, Y., Vonderembse, M., Ragu-Nathan, T. S., & Smith, J. T. (2014). Exploring relationships among IT-enabled sharing capability, supply chain flexibility, and competitive performance. *Int J Prod Econ*, 153, 24-34. doi: 10.1016/j.ijpe.2014.03.016.
- Patterson, K. A., Grimm, C. M., & Corsi, T. M. Adopting new technologies for supply chain management. [Online]. Available: www.elsevier.com/locate/tre
- Singh, A., & Teng, J. T. C. (2016). Enhancing supply chain outcomes through Information Technology and Trust. *Comput Human Behav*, 54, 290–300. doi: 10.1016/j.chb.2015.07.051.
- Neirotti, P., & Raguseo, E. (2017). On the contingent value of IT-based capabilities for the competitive advantage of SMEs: Mechanisms and empirical evidence, *Information and Management*, 54(2), 139–153. doi: 10.1016/j.im.2016.05.004.
- Octavia, A., Sriayudha, Y., & Ali, H. (2020). "Innovation Capability and Supply Chain Management: Empirical Study of Indonesian Traditional Herbal Medicine Products," Online, 2020. [Online]. Available: <http://excelingtech.co.uk/>
- "[https://www.aeologic.com/blog/the-role-of-it-in-supply-chain-management/#:~:text=The%20role%20of%20IT%20in%20supply%20chain%20management%20is%20so,for%20optimum%20supply%20chain%20perf](https://www.aeologic.com/blog/the-role-of-it-in-supply-chain-management/#:~:text=The%20role%20of%20IT%20in%20supply%20chain%20management%20is%20so,for%20optimum%20supply%20chain%20performance)ormance."
- "<https://ecampusontario.pressbooks.pub/logistics01oerfc/chapter/chapter-2/>."
- Magd, H., Ansari, M. S. A., & Negi, S. (2023). "Impact of Blockchain Technology on Operations and Supply Chain Management Performance," in *Proceedings of the 1st International Conference on Innovation in Information Technology and Business (ICIITB 2022)*, Atlantis Press International BV, 22–35. doi: 10.2991/978-94-6463-110-4_3.
- Mohsen, B. M. (2023). "Impact of Artificial Intelligence on Supply Chain Management Performance," *Journal of Service Science and Management*, 16(1), 44–58. doi: 10.4236/jssm.2023.161004.
- "<https://www.eazystock.com/blog/warehouse-technology-and-automation-supply-chain-management/>."
- Chaudhari, N. (2019). "Impact of Automation Technology on Logistics and Supply Chain Management," *American Journal of Theoretical and Applied Business*, 5(3), 53. doi: 10.11648/j.ajtab.20190503.12.

22. "https://predikdata.com/big-data-and-its-impact-on-the-supply-chain/."
23. "https://www.threadinmotion.com/en/blog/the-role-of-big-data-in-logistics-and-supply-chain-management#:~:text=Big%20data%20analytics%20facilitates%20collaboration,schedules%2C%20and%20optimize%20inventory%20levels."
24. Xia, J., Li, H., & He, Z. (2023). "The Effect of Blockchain Technology on Supply Chain Collaboration: A Case Study of Lenovo," *Systems*, 11(6). doi: 10.3390/systems11060299.
25. Mohsen, B. M. (2023). "Impact of Artificial Intelligence on Supply Chain Management Performance," *Journal of Service Science and Management*, 16(1), 44-58. doi: 10.4236/jssm.2023.161004.
26. "https://market-insights.upply.com/en/author/christopher-conolly."
27. "https://www.assetinfinity.com/blog/top-3-ways-qr-codes-can-simplify-inventory-management-in-warehouses#:~:text=4.,chain%20management%2C%20and%20reduce%20waste."
28. "https://www.letstrack.in/the-impact-of-gps-trackers-on-the-logistics-and-supply-chain-industries?Blogid=251."