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Supply Chain Digitization: Current Status, Challenges and Future Trends

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Abstract

In the report of the 20th National Congress of the Communist Party of China, it was mentioned that "efforts should be made to improve the resilience and security level of the industrial chain supply chain" and "accelerate the construction of digital China", emphasizing the need to strengthen the digitization and information construction of the logistics supply chain, promote the development of the digital economy, and create intelligent and high-quality supply chain services, which pointed out the direction for the development of the supply chain. At present, the coordination and optimization of supply chain is the key to improve enterprise performance. It is of great practical significance to study how to ensure the stable operation of supply chain. This paper focuses on the current situation of supply chain digitization, discusses the possible challenges of supply chain digitization, and analyzes the future development trend of supply chain digitization. The research work provides some reference value for the majority of scholars and enterprise supply chain managers, and provides some research ideas for the future supply chain digital reform.

Keywords

Supply Chain; Digitalization; Supply Chain Digitalization.

1. Introduction

In recent years, a new round of scientific and technological revolution and industrial transformation has accelerated, the world economic pattern has been profoundly reshaped, and Chinese enterprises have also experienced the wave of global supply chain reconstruction and digital transformation, and the competition among enterprises has gradually evolved into supply chain competition, and the digital transformation of supply chain has become the key to maintain competitiveness. In August 2022, China Federation of Logistics and Purchasing officially released the Evaluation Model of Digital Maturity of Procurement Supply Chain of State-owned Enterprises, which provides a scientific evaluation standard for supply chain digitalization and also reflects the practical significance of digitalization in promoting the transformation of supply chain management [1].

According to the report "China Enterprise Digital Transformation Index 2022", the digital transformation index of Chinese enterprises rose from 37 in 2018 to 52 in 2022, and the overall level of enterprise digitalization has steadily improved. However, the study found that there are still many enterprises that are unwilling to carry out digital transformation, or digital transformation fails, and the transformation effect is less than expected. According to the Accenture report in 2021, only 16% of enterprises in China have good benefits after digital transformation, and most enterprises have a phenomenon of "digital paradox" in the transformation, indicating that many enterprises are difficult to achieve expected returns in digital transformation[2].

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At present, although many scholars have conducted research on digital transformation, most of their research focuses on the results of digital transformation, such as the impact of digital transformation on production factors and industrial structure changes, etc. The existing literature still lacks in-depth research on the status quo, challenges and future trends of digital transformation of supply chain. Therefore, it is difficult to explain the digital paradox. The digital transformation of enterprises has become a "black box" with many puzzles to be solved. Therefore, this paper analyzes supply chain digitalization from three dimensions: current situation, challenge and future development trend, and explores the influence mechanism of supply chain digitalization on enterprise performance. It is hoped that it can reveal the "veil" of the role of digital transformation, and provide theoretical reference and reference for enterprises to implement digital transformation strategy and improve performance.

2. Supply Chain Digitization Theory Review

The attention paid to supply chain digitization indicates that digital transformation is an important trend of economic development [3]. For the definition of supply chain digitalization, foreign scholars more often believe that digital technology is used to create a more intelligent supply chain network architecture, or based on the Internet, the Internet of things, etc., to promote the connection of supply chain channels to achieve the intelligent supply chain system and to achieve the two-way interconnection of supply chain enterprises and channels. This enables more information to be integrated to make more accurate predictions and analyses [4].

However, domestic scholars are less involved in the field of supply chain digitization. The State Council first proposed the "Internet Plus Action Plan" in 2015, which strongly encourages traditional manufacturing enterprises to integrate digital innovation technologies such as the Internet and cloud computing into their daily operations. Since then, scholars have begun to study from the perspective of smart supply chain and digital supply chain. Smart supply chain is an intelligent supply chain system built by integrating technological innovation such as the Internet, cloud computing and big data with methods and technologies in modern industrial supply chain management [5]. Smart supply chain is committed to the application of digital technology to eliminate the information asymmetry in the process of supply chain information transmission, information exchange is not timely and other problems, from the terminal to solve the dilemma of supply chain operation.

With the increasing attention paid to digital technology at the supply chain management level, digital transformation and upgrading are urgent at the supply chain level. Digital supply chain can not only realize the intelligent processing and application of data in logistics, capital flow, business flow and information flow, so as to realize the global intelligent production, but also play a certain role in the formulation of business decisions and the optimization of operation costs, and can use data analysis to meet the corresponding needs of consumers. Digital supply chain refers to the use of digital technology to simplify transaction patterns, accurately identify needs and optimize product quality and efficiency, so as to make supply chain operation more intelligent, so as to achieve end-to-end supply chain coordination and agile operation [4]. Scholars define supply chain digitalization more from the perspective of supply chain process, and believe that supply chain digitalization is the use of digital technology to achieve efficient operation of business and capital operation[6]. Integrate data resources, information resources and technical knowledge resources through standardized mode, data analysis and sharing operation, so as to arrange business activities more reasonably. Radling (2020) believes that digital supply chain is a process of incremental accumulation of data and information by building a multi-channel platform, fully understanding customer needs with information, improving efficiency while reducing operational risks to ensure smooth operation[7]. Cennamo (2020) believes that in the digital transformation of supply chain, the overall change of the

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organization is more from the adjustment of the strategy, entrepreneurial process, corporate governance mechanism and innovation mechanism of the enterprise, and the enterprise will re-examine the relationship between the organization and the enterprise on the chain[8]. Zhai Qiong (2022) believes that digital supply chain will run data analysis through the whole link from information collection to data application, further divide processes and links, clarify responsibilities and work results, which can greatly improve work efficiency, build a rigorous and complete data logic, strengthen the connection between departments, and reduce information asymmetry[9].

Li Jingjing (2022) believes that digital supply chain is a customer-centric, demand-driven ecosystem combined with technologies such as the Internet of Things[10]. This system has three characteristics of integrated innovation, ecological link and flexible customization, which can create greater economic value for enterprises on the one hand, and accelerate the efficiency and quality of economic cycle from the social level on the other hand. According to other studies, the digital transformation of supply chain is the process of optimizing or reconstructing the business model and business value chain of supply chain related businesses by using new digital technologies and supporting capabilities around the core business of supply chain. The digital transformation of the supply chain reflects the idea of upstream and downstream integrated management of the supply chain under the mode of big data. One of its features is that data supports business collaborative operation and management decision-making, meets the needs of the entire supply chain in terms of rapid market response, efficient upstream and downstream collaboration, and effective risk control, and enables enterprises to improve quality and efficiency (Li Wujie et al., 2023)[11].

To sum up, this paper believes that supply chain digitalization is the full application of cloud computing, big data, Internet of Things, artificial intelligence and other digital technologies to digitize and integrate and share the information, technology, knowledge and other resources of the supply chain network, which can promote the best matching of resources to realize the new value creation of the supply chain network.

3. Practice of Supply Chain Digitization

Enterprise supply chain digitization is a continuous operation process, which is a process of "business - technology - data - talent" interaction and mutual iteration. The digital process of all links in the supply chain of enterprises needs to keep pace with and coordinate with the management ability and quality of enterprises, so as to ensure that enterprises can maintain competitive advantages in the face of fluctuating markets and complex external environments [12]. Queiroz et al. (2019) believe that a supply chain with special digital capabilities actually has the ability to build data-related capabilities in its products or services, which increases the flexibility and response speed of the supply chain, so that it can respond quickly to the end market and enhance the enterprise value in the process of continuously meeting the needs of customers[13]. Yang et al. (2021) point out that supply chain digitalization not only changes the supply chain structure and promotes the sustainability of the supply chain, but more importantly has a profound impact on the efficiency and innovation of supply chain management. The improvement of management efficiency enables enterprises to allocate resources in a more effective way, which helps to reduce business costs and reduce environmental risks. At the same time stimulate the growth potential of enterprises, and ultimately improve the business performance of enterprises[14].

Through the extensive use of digital technology, digital supply chain has many advantages that traditional supply chain does not have (Wang Weilei, 2021)[15]. For example, Haddud & Khare (2020) points out that digital supply chains can provide better visibility and traceability, better error identification and risk management, and ensure the quality of products and services; It

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can provide real-time data and share information, improve the visibility of the entire supply chain, perform better inventory management and control, and effectively control inventory and transportation costs; Through data collection and analysis, better demand forecasting and responsiveness can be achieved to meet the changing needs of customers. Big data can be used to calculate the optimal path, improve delivery capabilities, and enhance customer satisfaction.

Taking the domestic industry leader Jingdong Logistics as an example, Jingdong Logistics has been leading the development of China's logistics industry in terms of logistics digitization and automation, and has taken the lead in establishing China's first 5G intelligent logistics demonstration park. The park relies on 5G network communication technology, applies a number of intelligent logistics technologies and products such as AI and automatic driving, and builds a typical application scenario of 5G technology in intelligent logistics. The 5G network will cover all aspects of logistics transportation, warehousing, distribution, etc., so as to achieve real-time monitoring and process optimization, and realize the integration of intelligent decision-making.

In May 2019, Jingdong Logistics conducted China's first city-level intelligent logistics scenario application test in Xiamen, which was fully covered by 5G network and realized vehicle-road collaboration of the system management platform (Ge Hu and Zheng Yan, 2020)[16]. In November of the same year, at the Global Intelligent Logistics Summit, JD Logistics released the 5G intelligent open platform - LoMir for the first time. The platform forms an open 5G intelligent logistics application system with 5G+ iot + artificial intelligence as the underlying core (Chen Yuxin,2021)[17]. In 2020, Jingdong Logistics will integrate 5G with AI, intelligent robots and 5G technology + V2X in intelligent transportation, so that Jingdong Logistics will enter a new stage in the construction of 5G intelligent logistics. In 2021, JD Logistics conducted 5G application pilots in Changsha and Beijing Smart Logistics Park, including a large number of applications of 5G and AGV (Automated Guided Vehicle)[18].

The large-scale and multi-scenario application of robots and advanced technologies is the biggest feature of Jingdong Logistics automated unmanned warehouse. In the whole process, from warehousing, bag supply, sorting, and then package collection and transportation, robots with different functions and characteristics cooperate with each other to process orders according to system instructions, realizing automatic avoidance, path optimization and other functions. Improve Jingdong logistics operation efficiency and service quality.

4. The Impact and Challenge of Supply Chain Digitization

Although supply chain digitization can bring certain opportunities and benefits to the development of enterprises, enterprises still face significant challenges in the process of promoting supply chain digital transformation. First, the initial investment in digital transformation is large, including the purchase of hardware and software, the cost of consulting services, and the cost of staff training. In order to ensure the successful implementation of the project, enterprises also need to conduct a comprehensive cost-benefit analysis, evaluating direct costs and indirect benefits, and calculating long-term return on investment (ROI). For example, potential benefits such as reduced inventory costs, reduced labor errors, and improved order fulfillment speed need to be weighed against upfront investment. In addition, reasonable allocation of resources is also key, by setting priorities and phased implementation strategy, enterprises can control the budget while gradually advancing the project, so as to maximize the allocation of resources and achieve the expected economic benefits.

In addition, as supply chains become more digitized, data security and privacy protection become particularly important. Companies must address the increasingly complex risks of data breaches and ensure compliance with relevant laws and regulations. To this end, strong encryption technology is needed to protect the security of data transmission and storage, while

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strict access control mechanisms are implemented to ensure that only authorized personnel can access sensitive information. Conduct regular security audits and vulnerability scans to discover and fix potential security hazards in a timely manner. In addition, companies need to comply with regulations such as the General Data Protection Regulation (GDPR) or China's Personal Information Protection Law (PIPL) to ensure that all operations are compliant. The use of blockchain technology and smart contracts can further enhance the transparency and traceability of the supply chain, automate the enforcement of contract terms and streamline the payment process, while providing a transparent and verifiable record of transactions throughout the process. The establishment of a multi-layer protection system and the development of a detailed emergency response plan will help enterprises to respond quickly and resume business operations in the face of network security threats.

Whether it is managing costs and return on investment, or ensuring data security and privacy, it is an indispensable part of the digital transformation process of the supply chain. Effective planning and management can not only help companies overcome these challenges, but also deliver significant competitive advantages and long-term value.

Still taking Jingdong Logistics as an example, Jingdong Logistics adheres to technology-driven development, and the application of advanced technologies such as 5G network, unmanned warehouse, and drones has improved the operation and management efficiency of Jingdong logistics. There is no doubt that the application of advanced technology has many advantages, but it also brings challenges to the information security management of enterprises. With the in-depth development of digital supply chain business, JD Logistics continues to build a three-dimensional protection system of information security and intellectual property rights, providing solid technical support for the company's long-term operation, customer privacy security and protection of core intellectual property rights.

Information security is the basic concept of compliance management firmly established by every Jingdong logistics person. Since 2022, JD Logistics has completed the online information security training and examination covering 100% of its employees, and continues to push information security posters to all employees through the official publicity channels of the company to continuously improve employees' awareness of information security (ESG report, 2023). For all employees of the enterprise, they must receive information security training and pass the exam every year; For new employees, passing the information security course assessment is a necessary link in the probation period; For product R&D personnel, they must receive special training on information security skills and anti-phishing.

In addition, due to immature technology, lack of supporting policies and other factors, logistics unmanned is still in the initial stage. And any technology has its appropriate conditions, logistics automation system is not omnipotent. Taking unmanned warehouse as an example, due to the many links of logistics operations, complex site conditions, and diverse logistics operation objects, it is difficult to standardize products, equipment, and operation processes. It is still quite difficult to completely replace manpower with equipment, realize the unmanned operation of all logistics operations in warehouses or factories, and achieve the balance of efficiency, quality and cost.

5. Future Development Trend of Supply Chain Digitization

5.1. Deeper Technology Integration

As technology evolves, supply chain management is likely to see more deep integration between different technologies. For example, iot devices are able to collect and transmit data in real time, which can be analyzed by artificial intelligence (AI) and machine learning (ML) to optimize supply chain processes. Blockchain technology provides a secure and transparent way to record transactions and track goods. This multi-technology convergence will not only

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increase efficiency, but also enhance transparency and traceability in the supply chain. By leveraging these technologies, companies can reduce operating costs while improving customer satisfaction and service levels.

Application example:

Predictive maintenance: Reduce downtime by installing sensors on critical equipment that monitor equipment status in real time and use AI algorithms to predict when maintenance is needed.

Smart contracts: Use blockchain technology to automate the execution of contract terms, ensuring compliance by all parties while streamlining the payment process.

5.2. Intelligent Supply Chain

The supply chain of the future will not just respond passively to market demand, but proactively anticipate and adapt to change. With AI and ML, the system can make decisions based on historical data and current market trends, such as inventory level adjustment, transportation route optimization, etc. In addition, robotics and automation will be further developed to make warehouse management and logistics distribution more efficient.

Application example:

Demand forecasting: Use ML models to analyze consumer behavior patterns and predict demand peaks or troughs in advance to better plan production and inventory.

Dynamic pricing: Adjust product prices based on real-time supply and demand to maximize profits while remaining competitive.

5.3. Enhanced Data Analysis Capabilities

Advances in big data technology are providing businesses with unprecedented opportunities to make sense of and leverage the vast amounts of information they have. With advanced data analytics tools, companies can tap into the insights hidden in their data to improve their supply chain strategies. For example, by analyzing social media data to understand consumer preferences, or using sensor data to monitor product quality and shipping conditions.

Application example:

Supply chain Visualization: Create real-time supply chain views with data analytics tools to help businesses quickly identify bottlenecks and potential problems.

Risk assessment and management: Plan ahead by analyzing the impact of global events (e.g., natural disasters, political instability) on supply chains.

5.4. Sustainability and Green Supply Chains

Faced with increasingly serious environmental problems, more and more enterprises begin to attach importance to sustainable development and incorporate it into their supply chain strategies. This not only helps to meet regulatory requirements and social responsibility, but also appeals to an environmentally conscious consumer base. Implementing a green supply chain strategy includes measures such as adopting clean energy, reducing waste emissions and choosing sustainable materials.

Application example:

Carbon Footprint Tracking: Use blockchain technology to accurately track the carbon emissions of a product throughout its life cycle, from raw material to finished product, to help businesses and consumers make greener choices.

Closed-loop supply chain: Establish a recycling system to re-enter waste products and packaging materials into the production cycle and reduce resource waste.

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6. Conclusion

This paper makes a comprehensive analysis of supply chain digitization from three dimensions: current situation, challenge and future trend. Supply chain digitization is not only one of the key drivers of the current global economic development, but also an important means for enterprises to enhance competitiveness and achieve sustainable development. The report of the Party's 20th National Congress emphasized "focusing on improving the resilience and security level of the industrial chain and supply chain" and "accelerating the construction of digital China", which provides a clear direction and support for the digitalization of supply chains.

By reviewing the basic theories of supply chain management and combining the research results of domestic and foreign scholars, this paper expounds the definition and importance of supply chain digitization. Supply chain digitalization is not only the use of digital technology to simplify transaction patterns, accurately identify needs and optimize product quality and efficiency, but also by integrating advanced technologies such as cloud computing, big data, Internet of Things and artificial intelligence to build an intelligent, transparent and traceable supply chain network architecture. This system not only improves the operational efficiency and management level of enterprises, but also enhances the overall resilience and flexibility of the supply chain.

In the practical part, this paper takes JD Logistics as an example to demonstrate the significant advantages of digital supply chains in improving visibility, traceability, inventory management, and demand forecasting. However, enterprises also face many challenges in the process of advancing the digital transformation of the supply chain, such as high initial investment costs, data security and privacy protection. Effective planning and management are key to overcoming these challenges, and the expected economic benefits and competitive advantages can only be achieved through rational allocation of resources, strict data protection measures, and continuous technological innovation.

7. Give Directions Or Suggestions for Further Research

Although this paper has explored supply chain digitization in a more comprehensive way, there are still many areas worth further research in this area:

1) Cross-industry application case analysis: Although this paper takes Jingdong Logistics as an example to demonstrate the application of supply chain digitization, the supply chain structure and demand of different industries are quite different. In the future, we can further study supply chain digitization practices in other industries, such as manufacturing, retail, healthcare, etc., to explore their unique application scenarios and best practices.

2) Sme digital transformation path: Most existing research focuses on large enterprises, while smes face more resource constraints and technical challenges in the process of digital transformation. Future research can focus on how to help smes successfully achieve the digital transformation of the supply chain, providing more targeted solutions and support strategies.

3) Policy support and standard setting: Governments have an important role to play in driving the digitization of supply chains. Future research could explore how to promote the development of supply chain digitization through policy support, laws and regulations, and standardization, especially in the areas of data security, privacy protection, and information sharing.

4) Impact of emerging technologies: As emerging technologies such as 5G, quantum computing, and edge computing continue to evolve, they will have a profound impact on the digitization of supply chains. Future research could explore how these new technologies can further optimize

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supply chain management processes and improve supply chain responsiveness and decision-making.

5) Green supply chain and sustainable development: With the increasing global concern for environmental protection, green supply chain will become the focus of future development. Future studies can further explore how to achieve low-carbon and circular economy development of supply chain through technological innovation and management optimization, and propose specific implementation paths and evaluation methods.

In short, supply chain digitization is a complex and multi-dimensional topic, involving many aspects such as technology, management, economy and society. Through continuous deepening of research, we can better understand its internal mechanism and development law, provide valuable reference and guidance for enterprises and policy makers, and promote supply chain digitalization to a higher level.

References

[1] Ma Chunying. Research on Working capital Management Performance of Hikvision under digital supply chain [D]. Shandong Normal University, 2023.

[2] Yang Dong, Chen Chao, Yang Peng. Digital degree, dual innovation and firm performance [J]. Statistics and Decision, 2019,39(19):167-172. (in Chinese)

[3] Xu J. Technology Foundation and Talent Management for Digital Enterprise[M]. Managing Digital Enterprise. Atlantis Press, Paris, 2014: 27-49.

[4] Accenture. Six Keys to Digital Supply Chain [J]. Software and Integrated Circuits, 2020, (Issue 1).

[5] Song Hua. Emerging technologies and smart Supply chain innovation under "Industrial Supply chain +" and "Internet +" [J]. People's Forum · Academic Frontier, 2015(22):21-34.

[6] Li Haiyan. Research on digitalization of manufacturing supply chain [J]. Chinese and Foreign Entrepreneurs, 2019, 632(06): 68.

[7] Radlin. Research on the trend of digital transformation of Automotive supply chain after COVID-19 [J]. China Logistics and Purchasing, 2020, (15) : 38-39.

[8] Cennamo C. et al. Managing Digital Transformation: Scope of transformation and modalities of value co-generation and delivery[J]. California Management Review, 2020, 62(4): 5-16.

[9] Zhai Qiong. Motivation and technological impact of digital transformation of financial sharing Services [J]. Chief Accountant of China, 2022, (04) : 178-180.

[10] Li Jingjing. On the digital Supply chain transformation of "Enablers" and "Enablers" -- A Case study based on Lenovo's global supply chain [J]. Science of Science and Management of Science and Technology, 2022, 43(12) : 117-131.

[11] Li Wujie, Jiang Junfeng, Wang Huijie. Building digital Supply chain: Construction and application of e-commerce Big data platform [J]. Shanghai Information Technology, 2023,(05): 36-39.

[12] Queiroz M. M., Pereira S., Telles R., et al. Industry 4.0 and Digital Supply Chain Capabilities: A Framework for Understanding Digitalization Challenges and Opportunities[J]. Benchmarking An International Journal, 2019, 28(5):1761-1782.

[13] Yang, M. , M. Fu, and Z. Zhang. The Adoption of Digital Technologies in Supply Chains: Drivers, Process and Impact[J]. Technological Forecasting and Social Change, 2021,169,120 795.

[14] Wang Weilei. Study on the impact of supply chain digital transformation on retail enterprise operation performance [D]. Shanxi University, 2021.

[15] Abubaker Haddud, Anshuman Khare. Digitalizing supply chains potential benefits and impact on lean operations[J]. International Journal of Lean Six Sigma, 2020, 11(4): 731 -765.

[16] Ge Hu, Zheng Yan. Application research of 5G network in logistics industry [J]. Logistics Engineering and Management, 2019, 42(01) : 73-74 + 91.

[17] Chen Yuxin. 5G helps the development status and future exploration of intelligent logistics [J]. China Market, 2021(08) : 149-150 + 188.

ISSN: 2688-9323

[18] Jingdong Logistics Environmental, Social and Governance Report 2022. 2023. Available from:https://www.jdl.com/esgreport.