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RESEARCH ARTICLE

RAISING PERFORMANCE BY INTELLIGENT SUPPLY CHAIN REFORM

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Abstract

The fourth industrial revolution has created new opportunities for global industries. This dissertation discusses the advantages of supply chain intelligence and proposes a framework for the intelligent supply chain reform of small and medium-sized enterprises (SMEs). The study confirms that the various technologies brought by Industry 4.0 will support the intelligent transformation of supply chains, with particularly significant benefits for SMEs. Given that the adoption of these technologies requires time to develop and mature, NVIVO12 is employed as the analysis software to select and analyze relevant literature from the past decade. This qualitative research applies word frequency analysis, node analysis, and text analysis methods. The dissertation identifies the key goals and directions for intelligent supply chain reform. Finally, it offers suggestions for SMEs reform and outlines potential directions for future research in the field.

Chapter 1Introduction

With the further acceleration of the process of economic globalization, global competition is increasingly fierce. In addition, the market turbulence caused by COVID-19 can't be ignored. For the supply chain, the deepening of economic globalization means higher requirements for the supply chain, which is reflected in the response speed, information sharing degree and flexibility of the whole supply chain (Yan et al. 2014). For enterprises, supply chain management is not only a management mode, but also a strategic asset (Fiksel 2013). In the turbulent economic environment, the competitiveness of enterprises depends more on the optimization of supply chain management. Therefore, the decision-making of supply chain management largely determines the success of an enterprise (Lummus and Vokurka 1999).

Although the concept of supply chain was established less than half a century ago, supply chain management has indeed brought huge profits to many enterprises (Christopher and Holleg 2011). Large enterprises have fully realized the benefits of supply chain management and gained the competitive advantages brought by supply chain management. However, small and medium-scale enterprises' understanding of the concept of supply chain lags behind that of large enterprises, which means that it is more difficult for small and medium-sized enterprises to achieve results in reducing costs and improving efficiency on the premise that the turnover is less than that of large

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enterprises (Chin et al. 2012). However, the overall economic environment has changed due to the impact of the war between Russia and Ukraine and COVID-19, and with the rapid economic development of the times, the original supply chain management model can no longer meet the current fast-paced trading model. In addition, the scope of supply chain management is expanding, and now even covers product development, product scrapping and other aspects (Fiksel 2013). However, this means that the disadvantages of the traditional supply chain such as the " bullwhip effect" caused by opaque information will be amplified with the continuous strengthening of the supply chain management function. Like the domino effect, the more powerful the supply chain management function, the more obvious the disadvantages will be, and the more negative effects will follow. Therefore, for enterprises, avoiding the disadvantages of the traditional supply chain as much as possible is the only way to obtain higher profits. Under COVID-19, it is an opportunity for small enterprises. In the case that the turnover of small and medium-sized enterprises is not as high as that of large enterprises of the same type and the bourgeoisie is solidified, further optimization of the supply chain can reduce the internal cost, which is the main method to expand the company scale and seize the market share (Arend and Wisner 2005).

The concept of Industry 4.0 was first proposed in Germany in April 2011 (Ghobakhloo 2020). Industry 4.0 includes three themes, namely, intelligent factory, intelligent production and intelligent logistics. With a series of innovations brought by Industry 4.0, supply chain management will be guided to reform towards intelligence (Xie et al. 2020). The intelligent reform of supply chain management means transforming the traditional supply chain into a comprehensive integrated system integrating intelligence, networking and automation (Schmidt et al. 2015). The transformation brought about by Industry 4.0, can effectively help the traditional supply chain integrate all departments including sales, operation, procurement, marketing, product development and manufacturing, and finally become a whole, so as to break the barriers between various departments, then effectively improving the flexibility and performance of the supply chain (Witkowski 2017). The demand for intelligent supply chain reform is due to the inherent defects of the traditional supply chain. Therefore, the reform of the intelligent supply chain should focus on the defects of the traditional supply chain. The defects of the traditional supply chain can be roughly divided into three categories, namely, data problems, process problems and management problems(Johannessen, n.d.). In terms of details, the first is the data problem, which can be understood as inaccurate data, poor authenticity, non-sharing, poor timeliness, etc. Inaccurate and untrue data will lead to a large deviation in the prediction of future customer demand, thus affecting the profitability of the enterprise. Poor timeliness will make it difficult for enterprises to keep up with market changes, which is reflected in the lack of flexibility in the supply chain. The non-sharing of data will lead to the most typical problem in the supply chain - the bullwhip effect. The second is the process problem. Among the process problems, the most obvious defects are unreasonable utilization of resources, low efficiency and poor reliability. The unreasonable allocation of resources will bring high costs to the enterprise's inventory and production to a great extent. Low efficiency means that the enterprise will pay more salaries. The impact of these factors will undoubtedly increase the overall cost of the enterprise. Finally, there is the management problem. The management problem is reflected in the lack of strong cooperation between enterprises and the lack of clear standards for management. Therefore, these three reasons have greatly affected the performance of enterprises and brought more risks and uncertainties to decision-making.

However, as mentioned above, the traditional supply chain has some inherent defects. How to solve these problems or minimize the negative impact is a problem that all enterprises must face. Such as the sharing of information. The

sharing of information has always been the pain point of traditional supply chain management. The non-sharing of information creates the bullwhip effect. Meanwhile, the poor transparency of information brings great challenges to the product quality in the supply chain. There are numerous cases of product quality in the supply chain, such as the lead content in the paint of Mattel toys exceeding the standard, and the melamine content in Cadbury chocolate exceeding the standard (Zhou and Johnson 2014). Such accidents will undoubtedly hurt consumers' trust in the enterprise, thus leading to a decline in the turnover of the enterprise. At the same time, the response speed to the demand and recall of products in the supply chain is also a huge challenge (Lawson et al. 2019). The response speed of the supply chain largely determines whether the supply chain is efficient. In addition, the slow response speed of the supply chain will bring risks to some specific products, such as vaccines and food. Especially under COVID-19, different countries have issued different policies, which will bring many uncertainties to the transportation cycle. For the supply chain, the lead time becomes more inaccurate, which will aggravate the bullwhip effect and bring more challenges to the supply chain management (Bandaly, Satir, and Shanker 2016). To sum up, the importance of forecasting market demand and the response speed of the supply chain is highlighted.

Fortunately, with the maturity of high-tech technologies such as artificial intelligence (AI), the Internet of Things (IoT) and network physical systems (CPSS), it is possible for supply chain management to move towards intelligence (Xie et al. 2020). The innovation of the Internet of Things and cloud computing can provide solutions to some common problems existing in various types of supply chain management strategies, such as lack of timeliness of monitoring, traceability of logistics system, accuracy of data analysis and privacy of customer information (fore et al. 2016). Starting from the internal management and external environment, collaborative development is an important means to increase the core competitiveness of enterprises. Through the full coordination of information among the nodes of the supply chain, the root problems of the bullwhip effect and low information sharing in the traditional supply chain management mode can be effectively solved. At the same time, based on the information between the nodes of the supply chain, we can make more reasonable decisions for each department, and then effectively improve the value of the supply chain (Jiang 2019). In addition, the application of big data, machine learning and other technologies can make the supply chain management system more intelligent. The application of AI technology can enable the intelligent information management system to monitor the whole supply chain in real-time, which helps to reduce various typical problems of the supply chain represented by the uncertainty of delivery time (Alzoubi and Yanamandra 2020). The application of big data can fully understand the changes in market demand, improve the visibility and predictability of customer demand, and formulate different sales strategies according to different customer groups, then carry out more effective risk management. Based on the full use of these data, can help enterprises obtain more discount advantages in cooperation with suppliers (Schoenherr and Speier Pero 2015). Compared with traditional supply chain management, the intelligent reform of the supply chain can bring many strategic advantages such as higher production controllability, more comprehensive and reliable data, higher agility and so on. At the same time, the intelligent supply chain also has functions that the traditional supply chain does not have, such as product innovation, personalized service and green management risk warning (Walton, Handfield, and Melnyk 1998).

Supply chain management can be understood as an integration of suppliers, inventory, manufacturing and sales. In the whole process of production and sales, the correct goods are manufactured at the fastest speed and delivered to the next-level customers at the fastest speed, and the process is carried out at the lowest cost and the highest

efficiency, At the same time, it can meet the service level and the needs of customers (Qrunfleh and TARAFDAR 2014). Successful supply chain management can bring competitive advantages to enterprises from three aspects: value creation, efficiency creation and customer satisfaction (Lambert and Burduroglu 2000). Intelligent supply chain management can effectively amplify the advantages of these three aspects. Because of the above three problems in the traditional supply chain, the intelligent reform of the supply chain will effectively overcome the disadvantages and increase competitiveness.

Through the application of artificial intelligence (AI), it can help enterprises to establish an accurate and perfect management system, and artificial intelligence can set and implement management standards, to achieve standardized management. In addition, the application of big data can help enterprises to conduct accurate analysis and transfer in complicated and complicated data, help enterprises better understand customer needs, effectively reduce errors caused by future market demand changes, and save internal consumption such as inventory costs. Taking Dell as an example, the reason why Dell can save its inventory cost by adopting the production mode of "make to order" for a long time is due to the application of big data. Dell collects customer demand information through big data, collates this information, accurately forecasts market demand, and produces according to customer demand, thus reducing inventory costs. At the same time, the customized production mode has also improved Dell's product profit and customer satisfaction. The prediction of market demand changes can also help enterprises reduce the waste caused by unreasonable resource allocation, avoid the inventory cost caused by the backlog of unpopular products, and increase flexibility in supply chain management. It can be seen from Dell's case that the ability of intelligent supply chain management is not only a competitive advantage, but also one of the decisive factors for reducing internal costs and improving company performance (Tracey, Lim, and Vonderembse 2005). Then there is the application of machine learning technology, which can help enterprises greatly reduce labour costs in the production line. Simple repetitive labour will be carried out by machines, and employees only need to be responsible for maintenance and operation, that is, to realize the intelligent production mentioned in Industry 4.0. This will greatly improve the efficiency of the production process in the supply chain. At the same time, the consistency and standardization of the products produced by machines will be much higher than that of manual production. While ensuring production efficiency, it can also help enterprises reduce labour costs and improve product quality.

The application of cloud computing and the Internet of Things can also help enterprises realize the intelligence of logistics(Hämäläinen and Inkinen 2019). Logistics is one of the most important components of the supply chain. Logistics is a key step to connect suppliers at all levels, consumers and customers. Through cloud computing, it can realize the rational planning of freight routes, the selection of different types of logistics carriers, and even the use of complex logistics methods in the logistics process, for example, logistics strategies such as continental bridges are used to reduce transportation costs and meet customers' requirements for timeliness. Use the global positioning system of the Internet of Things to locate and track the goods, and increase the visibility in the logistics link of the supply chain to effectively evaluate and avoid potential risks. This is even more important during the COVID-19 epidemic period. Due to COVID-19, various countries have introduced different entry policies and isolation policies, which will deal a blow to the logistics industry to a large extent. The change of the entry policy and the isolation policy will prolong the transit time of logistics, and increase more uncertainty compared with that before COVID-19. Like the domino effect, this will hit production, storage, sales, customer satisfaction and other aspects. Therefore, the intellectualization of the logistics system becomes more important during the current epidemic. In addition, the

improvement of visibility will directly affect inventory management, and it will be easier for enterprises to predict replenishment lead time, inventory freezing period, etc. (Kohtamäki et al. 2017). Finally, through the application of various technologies in the Internet of Things, such as information sensors, radio frequency identification technology, global positioning systems, infrared sensors and other technologies, strengthen the supervision and management in the production and sales process, improve the controllability in the production process, reduce the intervention of human factors, overcome the defects in the process and management of the traditional supply chain, and realize the intelligent factory (Ben Daya, Hassini, and Bahroun 2017). Therefore, given the advantages brought by the intelligent supply chain, the transformation of the supply chain to intelligent will become particularly important for enterprises to improve their performance.

The purpose of this dissertation is to draw the advantages of an intelligent supply chain over the traditional supply chain and solve the inherent defects of the traditional supply chain by comparing the intelligent supply chain with the traditional supply chain. At the same time, it also studies how supply chain intelligence promotes the efficiency and performance of the enterprise supply chain. Finally, it provides a framework for small and micro enterprises to put forward suggestions and measures on how to realize supply chain intelligence. To achieve these three objectives, this study collected about 80 representative well-known enterprises, such as Dell, Nestle, Microsoft and so on, to analyze the cases of Supply Chain intelligence reform. At the same time, mass reports and periodicals related to supply chain intelligence have been collected as theoretical support to provide more powerful evidence for this study. This research adopts the qualitative research method and takes industrialization 4.0, IT, IoT, AI, CPSS, big data analysis and machine learning related to supply chain intelligence as keywords to analyze the advantages brought by supply chain intelligence from multiple perspectives, then provides a new idea for enterprises to solve the inherent problems of traditional supply chain through supply chain intelligence. In addition, combined with the experience of large enterprises in the case of intelligent supply chain reform, it provides a direction for the intelligent supply chain reform of small and micro enterprises.

This dissertation is divided into eight chapters. The first chapter introduces the research background and purpose of this dissertation. The second chapter explains the importance of studying supply chain intelligence. The third chapter reviews the relevant literature on the same topic and combines the contents of the first chapter, the second chapter and the literature review to get the research problems of this report. In the fourth chapter, the research problems and research methods are further clarified. The fifth chapter clarifies the type of data collection and research steps. The sixth chapter analyzes and reports the collected data. Chapter 7 will summarize and answer the research questions in this study and describe the findings of this study. Finally, in Chapter 8, we will critically reflect on the limitations of this study and provide a new direction for future scholars.

Chapter 2 Significance Of Research

Although the concept of supply chain has been widely praised since its inception, the rapid development of the times and the great changes in the economic environment have led to many difficult challenges for the traditional supply chain in the future, such as high inventory costs, excessive inventory products, Problems such as insufficient inventory products, mismatch between supply and demand and timeliness of delivery will become the Achilles' heel of supply chain management in the future economic environment that pays more attention to efficiency and timeliness, and has always troubled and restricted the further development of enterprises (Zhao, Ji, and Feng 2020).

The acceleration of the globalization process is both an opportunity and a challenge for enterprises. However, for the supply chain, it will aggravate its complexity and the uncertainty of customer demand. The attack of COVID-19 undoubtedly aggravates this phenomenon and also reflects the vulnerability of the supply chain. Companies all over the world need to face the challenges brought by the amplification of the inherent defects of supply chain management under the background of the times. In addition, the development of 5G, artificial intelligence (AI), Internet of Things (IoT) big data, cloud computing and other information technologies has brought disruptive changes to all walks of life, and the rapid flow of information and capital in the world has also increased the risks that wrong deployment will bring to enterprises (Siurdyban and Møller 2012). Therefore, the reform of the supply chain is the only way for all enterprises.

The intelligent reform of the supply chain is the key for all enterprises to adapt to economic globalization. To have a better future for enterprises, it is imperative to carry out intelligent reform of the supply chain. Supply chain management is of great significance to the manufacturing process and work, business model, products and services of enterprises (Agrawal and Narain 2018). However, the intelligent reform of the supply chain still faces challenges in many aspects, such as the willingness and ability of enterprises. Therefore, this paper focuses on the advantages of supply chain reform compared with the traditional supply chain, proves the necessity of supply chain reform to enterprises, and expounds on how the performance of the company will be improved after the intelligent supply chain reform, so as to improve the willingness of enterprises to carry out the intelligent supply chain reform. In addition, for small and medium-sized enterprises, in most cases, small and medium-sized enterprises often play a supporting role in the supply chain rather than a leading role. Therefore, how to reform their own supply chain is a huge challenge for small and medium-sized enterprises. This paper will learn from the experience of well-known enterprises such as Dell, provide a framework for small and medium-sized enterprises, help small and medium-sized enterprises to carry out intelligent reform of the supply chain and improve performance, and overcome the inherent defects of traditional supply chain.

In addition, the analysis of the traditional supply chain in this discussion can help small and medium-sized enterprises that are temporarily unable to realize the intelligent supply chain or other large enterprises that are facing the inherent defects of the supply chain to improve based on their conditions. At the same time, the analysis of the advantages and disadvantages of the traditional supply chain and the intelligent supply chain in this discourse can present a more intuitive conclusion for enterprises in the bottleneck period and uncertain about whether to carry out supply chain reform, which will help these enterprises further consider whether to carry out supply chain reform and make decisions based on their own conditions and challenges.

Finally, the research on the intelligent reform of the supply chain in this discourse is not only to improve the economic performance of small and medium-sized enterprises but also to help small and medium-sized enterprises follow the guidance of the three principles and make contributions to the realization of the United Nations sustainable development goals. Specifically, in terms of environmental performance, the research on intelligent supply chain processes in this paper can help small and medium-sized enterprises to reasonably allocate resources and save energy and non-renewable resources through data analysis (Shrouf, Ordieres, and Miragliotta 2014). At the same time, after realizing the intelligent supply chain, small and medium-sized enterprises can realize reuse and remanufacturing through product recycling, disassembly, and recycling (Sarkis and Zhu 2017). In addition, in terms

of social performance, the research on the intelligence of the supply chain in this discourse can help small and medium-sized enterprises to realize the automation of production and produce in a lower cost manner, thus avoiding the immoral problems caused by the use of child labour or the lack of employee welfare due to the cost reduction of small and medium-sized enterprises and improving social performance.

This discussion will focus on three aspects to help small and medium-sized enterprises analyze only the intelligent supply chain and the traditional supply chain, and solve the following problems:

1. Why is the intelligent supply chain better than the traditional supply chain?
2. How does the intelligent supply chain affect the economic performance, environmental performance, and social performance of enterprises?
3. How to promote the intelligent process of the supply chain?

Under the current background, this article will combine theory and practice, first analyze the defects of the traditional supply chain from the theoretical perspective, then explain how to overcome these defects through the intelligent reform of the supply chain and explain how the intelligent reform of supply chain will help enterprises to follow the three guiding principles and achieve economic performance, environmental performance and social performance at the same time. At the same time, it provides suggestions and solutions to the risks caused by the inherent defects of the traditional supply chain, to bring more competitive advantages to the enterprise itself in the future competition. Finally, it will combine theory and practice to bring a framework for the intelligent process of small and medium-sized enterprises, and help small and medium-sized enterprises accelerate the intelligent process of their supply chain.

Chapter 3 Literature Review

Introduction

Under the background of economic globalization, the digital consumption mode resets consumers' buying and purchasing habits. From the perspective of efficiency, the digital consumption mode has greatly accelerated the flow of funds. However, for the supply chain, the improvement of efficiency means that the information becomes more uncertain and will bring greater risks and destruction to the overall operation of the supply chain. For small and medium-sized enterprises, the consequences will be dissertation because of the information lag between the nodes of the supply chain and the misprediction of future market changes. As the key to enterprise profitability - supply chain, a complete and mature supply chain is an important competitive advantage for small and medium-sized enterprises in the context of economic globalization (Ni, Xiao, and lim 2019). A supply chain with both visibility and flexibility can bring profits and reduce costs for enterprises in terms of raw material acquisition, production line, logistics and sales, thus helping enterprises achieve success (giannakis and Papadopoulos 2016). To improve the visibility and flexibility of the supply chain, a large number of enterprises have moved towards the intelligent reform of the supply chain, making full use of the advanced technology brought by Industry 4.0, collecting information, sharing information, and forecasting supply and demand changes. And integrate and apply big data, artificial intelligence (AI), Internet of things (IoT), cloud computing and other technologies into the actual market competition, so as to improve the flexibility and visibility of the supply chain and provide sufficient reliable information and reference standards for decision-making at various nodes such as data management (min 2009). However, the application of this series of high and new technologies has not only brought advantages to enterprises but also risks or limitations.

At the same time, the intellectualization of the supply chain has an explicit correlation with the rise of costs, while the correlation between the intellectualization of the supply chain and the rise of profits is recessive. Therefore, many enterprises are limited by consciousness and knowledge and are not enthusiastic about the intelligent reform of the supply chain. In addition, for small and medium-sized enterprises, it is still challenging to realize the intelligence of the supply chain based on their own capabilities.

The purpose of this literature review is to decompose the abstract and invisible supply chain intelligence reform into modules through the review of the past literature and describe the advantages and disadvantages brought by the supply chain intelligence reform, industry 4.0 and the technologies that promote supply chain intelligent reform, such as the Internet of things, blockchain and artificial intelligence, Integrating various types of technologies to help small and medium-sized enterprises promote the process of intelligent supply chain.

Related concepts

Intelligent supply chain management

Intelligent supply chain management is an emerging product that combines the modern basic theory of supply chain management with Industry 4.0, including the Internet of things, CPS, cloud computing, big data, artificial intelligence, etc., transforming the traditional supply chain into a modern intelligent supply chain that integrates intelligence, networking and automation (Schmidt et al. 2015). The application of modern high-tech will transform the whole supply chain process from digitalization to a higher degree and a wider range of digitalization, integrate the value chain in the supply chain, make the whole supply chain more coordinated and flexible, and reflect its coordination and flexibility in production, transportation, warehousing and sales, to help enterprises achieve higher performance (De Souza, Borsato, and Bloemhof 2017).

The problem of traditional supply chain lies in the lack of visibility of information, and the neglect of information collection and management in the process of enterprise operation, which leads to slow information flow and poor accuracy of information, and finally leads to disconnection between various links of the supply chain or wrong decision-making due to wrong information. Therefore, the purpose of the reform of the intelligent supply chain is to enhance the circulation and visibility of information in the supply chain, reduce or eliminate the cognitive bias between links and departments, break the information barrier between departments, and integrate the supply chain into a whole (Nabhani et al. 2018). At the same time, the visibility of the supply chain will also lose its authenticity and timeliness due to the multiple transmissions and delay of information in the transmission process, leading to the emergence of the bullwhip effect, the intelligent reform of the supply chain can well avoid this phenomenon (Lee, Padmanabhan, and Whang 2015).

In the previous decades, although many supply chain management systems have been proposed by different scholars, these systems have defects in real-time monitoring, goods traceability and data analysis (fore et al. 2016). In addition, according to the observation of the traditional supply chain, the participants in the supply chain make strategies based on their interests, which leads to a crisis of trust between enterprises and makes it difficult to effectively communicate and cooperate, which is another reason for the poor speed of information flow in the supply chain (Jiang 2019). However, from the standpoint of enterprises, most enterprises are very concerned about the economic performance of the supply chain, followed by broader attention to reducing costs (Cheng et al. 2010),

improving service levels (Tan 2001), scientific decision-making (Van Donk and van der Vaart 2005). Therefore, the intelligent integration of the supply chain has become the only way for enterprises to improve performance (Yan et al. 2014). To sum up, intelligent supply chain management can bring a broader market and higher performance to enterprises. High and new technologies have changed the operation structure of the supply chain. Therefore, in recent years, many scholars have noticed the importance of intelligent supply chain management to enterprises and started research on the process of intelligent supply chain (Radanliev et al. 2020).

Although many scholars believe that the intelligent supply chain is an effective method to eliminate the problems of slow information transmission, poor flexibility and poor visibility in the traditional supply chain, many scholars believe that there are potential risks in the process of intelligent supply chain management. With the explosive growth of data in the information age and the acceleration of the process of economic globalization, challenges from network threats, data fraud, data leakage, hacker attacks and other moments threaten the digitalized network assets (Deiva Ganesh and Kalpana 2022). The intelligent reform of the supply chain is based on the application of network information technology. Therefore, the intelligent management of the supply chain may face challenges in network information security (Agyepong et al. 2019). In addition, the application of artificial intelligence and the Internet of Things also brings new challenges to customer privacy and security (Radanliev et al. 2020). The underlying logic of AI acting on intelligent supply chain management is to screen and analyze the data captured by big data and make scientific decisions. However, because the intellectualization of the supply chain will produce a huge amount of data, AI will increase the risk of data leakage and privacy leakage in the process of analysis. However, most scholars focus on how to apply AI and IoT technology, few scholars pay attention to network information security such as personal privacy disclosure caused by artificial intelligence and Internet of Things technology (Zhang et al. 2018). However, the traditional data supervision and security technology is effective for supply chain management, but for intelligent supply chain management with a large amount of data, the traditional monitoring methods lack the supervision of data, and it is difficult to capture the information in the process of supply chain operation in real-time, and there is a lack of methods to take data as the focus of monitoring, which is also one of the reasons for the challenges of network information security (Aboutorab et al. 2021).

In addition, there are also risks identified in the automatic and semi-automatic production process after the intellectualization of the supply chain. The first is to use the derivability problem, that is, when there is a leak in the memory, the wrong program will cause the machine to stop running or run incorrectly. Then, symbols have limitations in the process of execution, and the existing solutions are difficult to explore and reason the program path without executing through symbols, which will make it difficult to find program vulnerabilities. Finally, compared with other types of vulnerabilities, the vulnerability of the kernel in the operating system is more difficult to solve, and it is difficult to evaluate its impact. In addition, the vulnerability of the kernel in the operating system will improve the operation authority, thereby increasing the risk of critical data leakage (Wang et al. 2019). In addition, the intelligent reform of the supply chain has developed due to the emergence of Industry 4.0, but the technology is still immature. In the process of intelligent reform of the supply chain, the integration technology of the supply chain may lead to the emergence of network security risks. In addition to this factor, in the process of manufacturing automation, because network elements are integrated into the manufacturing industry, Therefore, it is difficult to ensure that there are no network risks (Radanliev et al. 2020).

At the same time, for small and medium-sized enterprises, the intelligent supply chain reform has some limitations. The role of small and medium-sized enterprises in the supply chain is often a participant rather than a rule maker, which means that the intelligent supply chain reform process of small and medium-sized enterprises often depends on large enterprises. Small and medium-sized enterprises do not have the ability to carry out intelligent supply chain reform by themselves, and small and medium-sized enterprises do not have a mature management system of large enterprises in the process of reform, there is also no professional knowledge and technical support, and there is a lack of sufficient financial resources to intelligently upgrade the infrastructure (Radanliev 2019). At the same time, due to the limitations of technical concepts, most of the modern technology integration of small and medium-sized enterprises in the process of intelligent supply chain reform revolves around the face of network information security and potential hidden dangers caused by network information security. Moreover, other studies have shown that there is a lack of relevant information between industries related to network ranking and digital infrastructure, which means that small and medium-sized enterprises still have great obstacles to overcome in applying network and digital facilities to the intelligent reform of supply chain (Agyepong et al. 2019).

Industry 4.0

Industry 4.0 is the fourth industrial revolution. Industry 4.0 has brought new and subversive intelligent technology and information technology to the world, which means more scientific and efficient production and decision-making for the development of enterprises (Bai et al. 2020). The technology of Industry 4.0 is more focused on the operation system and communication system of enterprises. For the supply chain, Industry 4.0 can help the supply chain integrate information and intelligent technology, and improve the flexibility and visibility of the supply chain (Jeschke et al. 2016). The technologies brought by Industry 4.0 include artificial intelligence (AI), big data, cloud computing, Internet of things (IoT), etc. These technologies have made great contributions to the innovation of enterprises in the context of economic globalization, which will bring many competitive advantages to enterprises in future competition (Dalenogare et al. 2018). The reason why Industry 4.0 is called the fourth industrial revolution is that it is a new industrial stage. In this stage, the manufacturing process is integrated into many aspects, thus enabling enterprises to obtain higher financial performance (Dalenogare et al. 2018). Industry 4.0 is a new mode. The purpose of Industry 4.0 is to be intelligent in the global machine network in the production process and realize highly automated information exchange and control, thus allowing the autonomous operation of intelligent factories (Tjahjono et al. 2017). For the supply chain, Industry 4.0 can enhance the transparency of the whole process in the cooperation process between manufacturers, suppliers and customers, which means that Industry 4.0 can contribute to the visibility of the supply chain from order production to delivery to product scrapping (Tjahjono et al. 2017).

In addition, Industry 4.0 can also bring advantages to enterprises in terms of environmental performance and social performance. The technologies brought by Industry 4.0, such as additive manufacturing and blockchain, can also help the supply chain achieve sustainability (stock and Seliger 2016). Because of the sustainable development goals (SDGs) proposed by the United Nations, the development brought by Industry 4.0 can respond well to the 17 goals of sustainable development (Robert, Parris, and Leiserowitz 2005). The traditional production technology has defects such as low resource utilization, high pollution and high emission. At the same time, the traditional production process will lead to environmental problems, including but not limited to global warming and sea level rise. At the same time, in order to save costs, businesses will use child workers in the production process or do not

guarantee the basic rights and interests of employees, resulting in problems in ethics and human rights (Tseng et al. 2018).

However, the fourth industrial revolution brought not only opportunities but also challenges and restrictions. First, Industry 4.0 has brought a large number of high-tech and accompanying products, which makes it difficult to make a very accurate assessment of the contribution of Industry 4.0 technology at this stage. Similarly, it is also difficult to analyze and judge the impact of Industry 4.0 in the supply chain (Dalenogare et al. 2018). Secondly, there is the issue of compatibility. Industrial 4.0 is in the stage of replacing the old with the new. At this stage, it is necessary to combine industrial 4.0 and the traditional production system. However, due to the huge difference in the level of technology contained in the new and old equipment, it is a huge challenge for compatibility (Bai, Kusi Sarpong, and Sarkis 2017). In addition, on the premise that the old equipment has not reached the retirement age, a large number of new equipment are purchased and the old equipment is blindly updated due to the incompatibility of new and old equipment, which will greatly increase the production cost for the enterprise. Similarly, in the case of large-scale replacement of old and new equipment, it is difficult for the replaced old equipment to be sold to other enterprises for secondary utilization, which also leads to a waste of resources, which conflicts with the original intention of industrial 4.0 application (Bai et al. 2020). Finally, there is uncertainty. As stated in the research of Dalenogare et al., the technology of Industry 4.0 has great uncertainty. Because the technology brought by Industry 4.0 is very novel and has a wide range of applications, it is difficult to evaluate the advantages and disadvantages of the technology of Industry 4.0 when it is applied to different environments and industries, there are likely many potential defects in Industry 4.0 in different industries (Dalenogare et al. 2018). In addition, the implementation of technologies brought by Industry 4.0 lacks an obvious correlation with sustainability. Therefore, it is difficult to define the extent to which the technologies of Industry 4.0 promote sustainable development (Bai, Kusi Sarpong, and Sarkis 2017).

In addition, based on the analysis of the environmental dimension, although most of the technologies of Industry 4.0 improve production efficiency and protect the environment, the use of high-tech will also bring higher energy consumption and other problems, which is contrary to the original intention of the application of Industry 4.0 technology. When enterprises use the technologies of Industry 4.0, it is difficult to balance economic growth and resource consumption (Bai, Kusi Sarpong, and Sarkis 2017). In addition, from the perspective of the social level, the implementation of the three themes of Industry 4.0, namely, intelligent factory, intelligent production and intelligent logistics, will bring high production efficiency. However, the realization of these three themes will also bring many social problems. For example, the bottom workers lost their jobs because of the emergence of intelligent production and data security after large-scale informatization. At the same time, complex and huge data will lead to a higher entry threshold for the industry, and it will be difficult for people with low education to find jobs. Especially for developing countries, this problem will be more serious. The unemployment of a large number of low-educated people will become a social instability factor, leading to a series of social problems (Rojko 2017). Although Industry 4.0 can bring advantages in the three dimensions of the economic environment and society, the disadvantages brought by the technology of Industry 4.0 from the three aspects of the economic environment and society cannot be ignored. Industry 4.0 is more like a double-edged sword. How to use the advantages brought by Industry 4.0 in the right way in the appropriate fields is a key issue.

Big data

The concept of big data was first proposed in October 1997, and big data was used to visualize a huge database on the computer (Zhong et al. 2016). In the future development, the information sources of big data will become more extensive, including email, video, audio, images, search records, social networks, mobile phones, etc. The function of big data is to extract, store, manage, share and analyze these data, and finally present the data in a visual form (Sagiroglu and Sinanc 2013). The application scope of big data is very wide, including finance, economics, medical care, supply chain management and various types of manufacturing industries. For example, for supply chain management, big data can participate in logistics. Through the feature that big data can make data concrete, the supply chain has a stronger adjustment ability, i.e. flexibility, under the premise of demand and inventory fluctuations. At the same time, it collects customer information, observes and analyzes customer behaviour patterns, and conducts pricing and production based on the analysis data, thus bringing new competitive advantages (Zhong et al. 2016).

The role of big data in Supply Chain Management

1. Supply chain analysis

For improving the economic performance of the supply chain, the application of big data in the supply chain is called supply chain analysis, that is, the analysis of complex high-level data in the supply chain (Wang et al. 2016). Supply chain analysis can bring advantages to supply chain management through descriptive analysis, predictive analysis and normative analysis (Tiwari, wee, and Daryanto 2018).

2. Descriptive analysis

The significance of descriptive analysis for supply chain management is to visualize the intangible data, and analyze the events and the causes of the events, so as to help the management make better decisions. Descriptive analysis is mainly used to record and analyze data changes in inventory, cost, revenue and other aspects, and finally provide the company with visible conclusions of production, operation, sales, finance and inventory departments, so as to help the enterprise clearly understand its own problems and future direction (Souza 2014).

3. Prediction analysis

Prediction analysis is to use statistics, simulation and other methods to predict future data and obtain the future trend of change, so as to allow the enterprise management to make decisions. Through the prediction of the future, identify the risks and the causes of the risks, avoid the risks or adopt better ways to make new decisions, and finally bring competitive advantages to the enterprise. Forecast analysis is mainly used in supply chain management to analyze customer behaviour, draw conclusions, predict customer demand changes, future costs, inventory quantity, etc., save inventory costs, minimize or eliminate waste, etc. Prediction analysis can help enterprises obtain the possible future events in advance and prepare for upcoming events in advance. At the same time, it can be understood that prediction analysis is only based on statistical principles, and cannot perfectly predict the future, but at least it can bring more useful and reliable information for enterprise decision-making (Wang et al. 2016a).

4. Normative analysis

Normative analysis refers to the secondary analysis based on mathematical optimization and simulation technology, descriptive analysis and predictive analysis, and more comprehensive secondary analysis based on the current

situation and future trends to draw conclusions, to help enterprises make scientific decisions. Normative analysis plays an irreplaceable role in the company's decision-making. Normative analysis is mainly used in production, scheduling and inventory departments, and optimizes the production process to improve production efficiency. Normative analysis can be understood as a comprehensive analysis combining predictive analysis and descriptive analysis. Based on the data and conclusions of predictive analysis and descriptive analysis, comprehensive consideration is carried out to finally provide the optimal solution for the decision of the enterprise (Fan, Heilig, and Voß 2015).

5. Strategic procurement

Strategic procurement is one of the important means to achieve enterprise performance. Strategic procurement can contribute to enterprise performance in terms of cost, quality and delivery. In addition, the goal of strategic procurement is to establish long-term and stable cooperative relations with suppliers (Tiwari, Wee, and Daryanto 2018). The role of big data in strategic procurement is mainly reflected in the analysis and conclusion based on the annual report of the enterprise and the accurate and effective information to help the enterprise complete the supplier management decision (Tiwari, wee, and Daryanto 2018). In addition, big data can also analyze potential suppliers based on the annual reports and return on investment (ROI) of various departments of the enterprise, and select the most suitable partners through the use of big data to rate future suppliers (Jin and Ji 2013).

6. Supply chain network design

The supply chain network design is aimed at the strategic decision-making level of the enterprise. The supply chain network design determines the physical configuration of the supply chain, selects the starting point of distribution through big data, manages the warehouse operation according to the randomly generated big data, and at the same time, reasonably allocates the transportation mode and route to meet the needs of customers (Wang, Gunasekaran, and Ngai 2016). Big data can also provide implicit data and indirect costs such as service levels and fines for reference by enterprises. In addition, big data analysis also contributes to the United Nations' sustainable development goals. The supply chain network design can also open up a humanitarian supply chain, through the collection of big data information, such as quantity, type, speed and value, to ensure its contribution to disaster relief, medical care and Education (Prasad, Zakaria, and Altay 2016).

Big data in supply chain management has always been focused on collection and storage, and the use of this data is accompanied by risks (Dekker et al. 2013). In the study of Zhong et al., these risks can be divided into the following five: volume, velocity, variety, verification, and value.

Volume

In supply chain management, a large amount of collection and calculation of big data are carried out continuously. It is difficult for data collectors, transmission networks and storage facilities to meet the storage capacity of big data (Zhong et al. 2016).

Velocity

The huge data set in big data analysis is difficult to process at a fast speed, which may lead to the loss of timeliness of data-driven decisions. The speed of processing depends on the speed of data collection, the reliability of data

transmission, the efficiency of data storage, and the screening speed of effective information. Therefore, the huge amount of calculation is a great challenge to the timeliness of decision-making (Zhong et al. 2016).

Variety

Because of different data sources and different heterogeneous formats, big data in the supply chain will change at any time. New data will be obtained from sensors in different fields, such as production lines, retailers, and suppliers, etc. it is difficult to integrate complex data sources into standard formats for reference (Zhong et al. 2016).

Verification

In the process of big data analysis, a lot of invalid information will be collected. It is not easy to establish a standard to filter the data. At the same time, effective information or private information may be leaked while verifying the data. Under such a premise, it will become more difficult to verify and screen the information (Zhong et al. 2016).

Value

The value of big data in supply chain management is difficult to be intuitively reflected. The above four factors further increase the difficulty of enterprises in judging the value of big data. It is very difficult to review the conclusions and benefits brought by big data. In addition, decisions driven by big data statistical reports and intuitive data are affected by micro and macro factors, making it more difficult to judge their value.

Artificial intelligence (AI)

Artificial intelligence was initially defined as the ability of machines to acquire human abilities through human Artificial intelligence was initially defined as the ability of machines to acquire human abilities through human imitation, helping humans reduce the burden of thinking, and thus becoming a thinking machine that replaces human intelligence (Min 2009). For supply chain management, artificial intelligence is a brand-new technology, and it has been widely applied in the field of supply chain only recently. The application of AI can handle complex problems with higher accuracy, faster speed and greater information calculation amount in the process of supply chain management, thus contributing to supply chain management in the fields of information technology and finally enabling enterprises to gain competitive advantages (Jeschke et al. 2016). Through the application of deep neural networks, convolutional neural networks, mathematical optimization techniques in operational research, constraint programming and so on, artificial intelligence can obtain decision-making ability similar to human beings, thus making artificial intelligence an agent product with perception and action (Russell and Norvig 2016).

Machine learning is not only a technical branch of artificial intelligence, but also the core technology of artificial intelligence and data science. The method of machine learning can be applied to many fields, including but not limited to science, technology and business (Jordan and Mitchell 2015). Machine learning starts with the technology in the computer to learn and summarize the experience. The ability of machine learning can even find out the complex hidden relationship between information while processing a large amount of information, thus helping to make decisions in the thinking dimension that the human brain cannot reach (Ni, Xiao, and Lim 2019). In addition, machine learning in the medical field also shows its strong ability, such as cancer prediction, genetics and genetics. Machine learning can even replace the human brain for diagnosis, and has higher accuracy and predictability (Libbrecht and Noble 2015). Similarly, machine learning has unique significance for supply chain management. In

the process of supply chain management, it is necessary for decision-makers to make decisions under the condition of being full of uncertainties. At the same time, it is difficult to accurately predict future demand changes because of the opacity of information in the supply chain and the uncertainty of demand. However, machine learning can participate in the decision-making process of goods and services flow, to solve the difficulties and information obstacles in the decision-making process and enhance the visibility of the supply chain, Therefore, the prediction function of machine learning is of great significance for supply chain management (Gumus, Guneri, and Ulengin 2010).

Types of machine learning

The working principle of machine learning is to store, analyze and learn past data through computer programs, to complete complex tasks such as prediction, dispute, planning and identification based on past experience (Kang, Catal, and Tekinerdogan 2020). Machine learning can be divided into four types: supervised, unsupervised, semi-supervised and reinforcement.

1. Supervised

Supervised means that human help is needed. It will analyze the input data and output data generated from the selected data through computer programs to obtain the calculated function formula (Kang, Catal, and Tekinerdogan 2020). However, the role of human is irreplaceable in supervised. The user must select the data and control the parameters. Therefore, supervised is usually used under the premise that the user has sufficient knowledge of machine learning and has a certain understanding of the data object. In addition, supervision requires a large amount of data, so it has certain limitations in some fields that humans do not know much about (Kang, Catal, and Tekinerdogan 2020).

2. Unsupervised

The working mode of unsupervised is completely opposite to that of supervised. Unsupervised does not need any human factors at all. It can analyze data and provide conclusions for users without human screening data. In addition, unsupervised is mainly used to input data and establish data clusters (Kang, Catal, and Tekinerdogan 2020).

3. Semi supervised

Semi-supervised has higher accuracy than supervised. Semi-supervised can use the filtered data and the unfiltered data for analysis. Compared with supervised, the analyzed data samples are more comprehensive and therefore more accurate (Kang, Catal, and Tekinerdogan 2020).

4. Reinforcement

Reinforcement puts more emphasis on the intelligent observation of the environment, and changes the behavior according to the change of the environment, to obtain immediate benefits or punishment. Reinforcement uses its unique feedback mechanism to reward or punish behaviours. Reinforcement is mostly used in automatic driving or online games (Kang, Catal, and Tekinerdogan 2020).

Tasks of machine learning

1. Regression

Regression refers to inputting data into the sequence of selected data changes and then optimizing the independent variable coefficients to ensure the minimum error in future prediction(Kang, Catal, and Tekinerdogan 2020). For example, in the supply chain, future customer demand changes are predicted according to past customer demand changes, to ensure that the enterprise can effectively reduce the inventory cost and optimize the inventory preparation period and distribution cycle.

2. Classification

Classification refers to classifying data into a discrete data set and classifying problems based on the obtained results (Kang, Catal, and Tekinerdogan 2020). This can be applied to the production link of the supply chain. Through the classification of the problems generated in the production process, the root cause can be found and the possibility of similar problems in the future can be avoided.

3. Data reduction

Data reduction can back up and analyze the similarity between data and provide users with reliable information through the analysis of similar data (Kang, Catal, and Tekinerdogan 2020). For example, in the selection of long-term cooperative suppliers, the suppliers with the highest similarity with ideal medium and long-term partners can be found through the analysis of their own attributes to establish long-term relationships.

4. Clustering

Clustering is mainly used to filter data twice and delete some duplicate or invalid data, to improve the efficiency of machine learning. Clustering is mainly used to assist in expression and classification (Kang, Catal, and Tekinerdogan 2020).

5. Anomaly detection

Anomaly detection is carried out by unsupervised method, that is, more algorithms are used to group samples and detect abnormal data in the data set (Kang, Catal, and Tekinerdogan 2020). Analogue detection can be used to improve the quality of products in the supply chain. Through abnormal detection, the product parameters are inspected, to screen out unqualified products through abnormal data and finally improve the product quality.

In addition, machine learning can be used to optimize the production line from two aspects, namely, improving the quality of the product itself and optimizing the production process (weichert et al. 2019). From the perspective of cost reduction, machine learning also contributes. Machine learning can reduce the cost of raw materials and reduce the processing time by saving resources through rational allocation of resources and optimization of production lines, and can also improve the output when traditional methods such as the Six Sigma strategy reach the limit under the premise of cost reduction (K ö ksal, batmaz, and testik 2011).

After the application of machine learning in supply chain management, the expected results have not been achieved. This is mainly due to the lack of certain professional knowledge in the classification of machine learning or the guidance of machine learning among the relevant practitioners and stakeholders in supply chain management,

failing to select the most suitable and correct machine learning algorithm in the supply chain management, Finally, machine learning did not achieve enough significant effect in Supply Chain Management (Ni, Xiao, and Lim 2019). In addition, although artificial intelligence is accepted to a large extent and is widely used as a decision-making aid tool, the application of artificial intelligence in supply chain management is still limited, including various subsets of artificial intelligence, which are limited by economic and technical factors. For the artificial intelligence technology used in supply chain management, its role has not been played to the maximum, There is still much room for improvement in the application of supply chain management in the future (Min 2009).

Internet of Things（IoT）

The concept of the Internet of Things was first introduced by Kevin Ashton and other MIT scholars in 1999. The Internet of Things refers to collecting any object or process that needs monitoring, connection and interaction through various devices and technologies such as various information sensors, infrared sensors, and laser scanners, and collecting the basic elements of these objects or processes, such as sound, light, heat, electricity, mechanics, chemistry, biology, location and other fields, Through various possible network access, ubiquitous connection between objects or between objects and people can be realized, to realize intelligent perception, identification and management of objects and processes (Aryal et al. 2018). The three characteristics of the systematization of the Internet of Things are everything communications, everything is identified and everything interactions (Miorandi et al. 2012). In detail, everything communications means that wireless communication can realize the interconnection of things and networks; Everything is identified means that all elements connected in the Internet of Things have unique identification marks; Finally, there is everything interactions, which can sense the environment and interact with the environment (Miorandi et al. 2012). The application of IOT in real life is divided into three fields, namely, industry, smart city and Health Welfare (Borgia 2014). The application in the industrial field is reflected in the business activities and economic exchanges between enterprises, such as logistics, manufacturing and so on. The application of smart cities focuses on improving the environment of enterprises through the application of Internet of Things technology, making contributions to environmental sustainability, and paying more attention to efficient resource management. Health welfare refers to intelligent services derived to improve health activities and social development (Borgia 2014).

As for the application of IOT technology in supply chain management, it is mainly reflected in the solution of three difficult problems in the supply chain, namely, tracking, monitoring and coordination control (Jiang 2019). In terms of details, the Internet of Things can accurately provide relevant information about products to enterprises and participants in the supply chain throughout the supply chain, thus helping enterprises to improve the accuracy and frequency of receiving information (Rebelo, Pereira, and Queiroz 2021). At the same time, the application of IOT technology in the supply chain can also lead to the increase of information flow components in the supply chain, thus eliminating the information asymmetry among the nodes of the supply chain and the serious consequences caused by the information asymmetry (Rebelo, Pereira, and Queiroz 2021). In addition, some scholars believe that the technology of the Internet of Things needs to be combined with other industrial 4.0 technologies such as big data analysis and blockchain to give full play to the technology of the Internet of Things (Kshetri 2017). The combination of big data analysis and the Internet of Things can effectively sort and analyze a large amount of data generated by the Internet of Things. For example, big data can analyze the climate data information received by satellites and data sensors, analyze the future weather according to the known information, realize the prediction of

future weather, and help industries seriously affected by weather change to avoid risks in advance (Kamble, Gunasekaran, and Gawankar 2020). From the perspective of the combination of IOT and blockchain technology, the transparency of the value chain can be improved through different application scenarios, to increase the trust between various nodes, improve the efficiency of the supply chain, and reduce the related problems of enterprises in data security, such as incomplete data collection, difficult traceability of goods, information mismatch between various nodes, poor data security, etc. (Rejeb, Keogh, and Treiblmaier 2019). In addition, the integration of IOT and blockchain technology can also contribute to the scalability, security, invariance, audit, information flow, traceability and interoperability of IOT, to realize the idea of a logistics platform integrating IOT and blockchain (Rožman et al. 2019).

Advantages brought by the Internet of Things to the supply chain

1. Inventory management and warehouse operation

The application of the Internet of Things in supply chain management can optimize the process of warehousing operation, reduce labour costs, and effectively improve production efficiency (Georgakopoulos et al. 2016). In detail, from the perspective of inventory management, the technologies of the Internet of Things include intelligent forklifts, intelligent shelves and intelligent glasses, which can effectively locate the inventory quantity and location in the warehouse. At the same time, the storage software and surveillance cameras can also make the inventory more transparent (Rejeb, Keogh, and Treiblmaier 2019). For warehouse operation, the technology of the Internet of Things can be used to mark or label the fixed assets that can be used many times, to help warehouse workers reach the target location more efficiently (Rejeb, Keogh, and Treiblmaier 2019). At the same time, the Internet of Things can also help promote the automation process of warehousing and improve efficiency through the accurate positioning of products and materials in the warehouse. However, there is another advantage of the Internet of Things that cannot be replaced by labour. The automation of warehouses and distribution centres promoted by the Internet of Things can optimize the scheduling process of orders, reduce the risk and profit reduction caused by employee errors, and eliminate material waste through automation, to reduce labor costs and raw material costs. In addition, for the improvement of efficiency, enterprises can also use RFID and technology. RFID technology will be deployed at the transport terminal, and you can send pallets and product packaging boxes with RFID tags through the wireless belt of the terminal, to reduce the time cost of collecting data and inspecting and analyzing data, thus improving efficiency (Amador, Emond, and Nunes 2009). RFID tags can also prevent the barcode from being damaged or blurred in some cases, which makes it difficult to identify, and improve reading accuracy (Goyal et al. 2016).

2. Production and manufacturing operation

The implementation of the Internet of Things will bring many advantages to the production and manufacturing environment of enterprises. The large-scale application of microcomputers, microcontrollers, microprocessors and intelligent sensors can enable the production and manufacturing process to be monitored in real-time by these instruments with embedded sensors, thereby reducing production bottlenecks, enhancing the control ability of the operation Department for the set time and the amount of swallowing and spitting, and optimizing the production plan and scheduling plan at all levels in the enterprise (Rejeb, Keogh, and Treiblmaier 2019). In addition, the Internet of Things can also bring higher agility to enterprises through the immediate identification and predictive maintenance of mechanical errors (Waller and Fawcett 2013). In addition, the optimization of the manufacturing

process can also help enterprises to achieve deeper cooperation with suppliers at all levels in the supply chain, thus forming a win-win situation (Obitko, Jirkovský, and Bezdíček 2013)

3. Transportation operation

For the transportation process, the application of the Internet of Things can also bring advantages to enterprises. In detail, the Internet of Things has brought clearer standards or configurations to the transportation management system and promoted the intelligent process of transportation management (Barreto, Amaral, and Pereira 2017). For the transportation process of enterprises, the application of the Internet of Things can effectively optimize the transportation process, thus making the whole transportation process more efficient and flexible. Especially under the current COVID-19 background, the application of the Internet of Things is of great significance for the cold chain transportation of vaccines. The application of GPS technology can accurately locate the refrigerated truck carrying the vaccine from the remote distribution centre, and then reasonably plan the transportation route of the refrigerated truck. This can not only ensure the delivery time but also ensure that the vaccine will not be damaged due to uncertain factors during transportation (Rejeb 2018). In addition, GPS and RFID technology can measure the temperature and humidity through the connection with other sensors, and then conduct large-scale mapping, traffic data collection and analysis, to accurately locate the vehicles or cargo ships in the transportation process, thereby improving the visibility of the transportation process for the supply chain. At the same time, the information and data collected in the process of positioning in transit vehicles can also help enterprises to accurately predict delivery time and routing efficiency (Waller and Fawcett 2013). Similarly, these technologies can also be used in aspects such as parking spaces and road information, through information analysis and sharing, to optimize resource allocation and make full use of unused resources (Barreto, Amaral, and Pereira 2017).

Although the Internet of Things is the basic technology of Industry 4.0, the functions of the Internet of Things have not been fully utilized in supply chain management. The reason is that the management of the enterprise has not formulated relevant management plans based on the functions of the Internet of Things, and the cost of new technologies is too expensive for enterprises, especially for small and medium-sized enterprises. In addition, there is a lack of trust among the nodes of the supply chain, Unwillingness to share data and cooperate with each other is also one of the main reasons why the functions of the Internet of Things have not been fully developed (de Vass, Shee, and Miah 2021). In addition, the current research on the Internet of Things technology is highly decentralized, and most of the time only focuses on a single technology in the field of the Internet of Things (Tuncer, Mishra, and Shenoy 2012). Therefore, for enterprises, the development and adoption of IOT technology fragmentation is harmful (Miorandi et al. 2012). At the same time, there are still many technical challenges for the development and use of the Internet of Things. These technical challenges involve hardware, architecture, communication, data processing, data collection, network management, power and energy storage, security and privacy, etc. (Borgia 2014).

Blockchain

As one of the new technologies of Industry 4.0, blockchain is of great significance to supply chain management. The combination of blockchain and the Internet of Things and its application to supply chain management will bring about disruptive changes to supply chain management (Queiroz, Telles, and Bonilla 2019). The blockchain was originally defined as a decentralized and distributed digital ledger, and the transaction time was recorded in order, thereby achieving permanent records that cannot be modified (Treiblmaier 2018). In other words, blockchain can be

understood as a new mechanism for storing, protecting and facilitating users to share information between nodes in a network (Atlam and Wills 2019). blockchain is to manage data across distributed and interconnected node networks, thus breaking the traditional way of centralization. Therefore, the decentralization of blockchain can be integrated with the Internet of Things, to achieve data invariance, distributed trust and data tamper resistance (Treiblmaier 2019).

The most significant significance of blockchain for supply chain management is that it leads to the subversive transformation of supply chain management. Specifically, the change of the blockchain to the supply chain is the reconfiguration of the traditional model, to achieve decentralization in the transaction (Queiroz, Telles, and Bonilla 2019). The specific explanation is: that the blockchain writes the contract after the transaction is satisfied, and stores the code in the structure of the blockchain. Once the contract starts, the funds and commodities are transferred immediately, and the process does not require the participation of intermediaries. To achieve the purpose of improving efficiency, reducing costs and improving trust in supply chain management(Al-Saqaf and Seidler 2017).

The application of blockchain technology in supply chain management also includes smart contracts. Smart contracts are an indispensable part of blockchain applications. The original intention of smart contract design is to improve the relevant departments of the supply chain to obtain more benefits. However, non-long-term partners often lack trust due to their limited understanding of each other. However, blockchain can use technologies such as smart contracts to increase the value of various processes in the supply chain (Helo and Hao 2019). The application of smart contracts in supply chain management is also reflected in reducing the risk of receiving fraud, theft and other management aspects (Chang and Chen 2020). In detail, the blockchain ledger system can use home measures such as digital signatures to verify the authenticity of important information such as property and documents, thus eliminating the possibility of forgery (Toyoda et al. 2017). At the same time, small and medium-sized enterprises can reduce the time and energy used to process written documents. Through the tracking of goods and the acquisition of proven true information through blockchain technology, they can reduce massive labour and time costs (Chang and Chen 2020). Based on this, in the process of small and medium-sized enterprises conducting blockchain transactions, the work scheme of the supply chain is optimized by blockchain technology and smart contracts, to ensure higher transparency and traceability in the transaction process (Chang and Chen 2020). When the smart contract is used in the blockchain, the smart contract will be transferred to every connection point in the blockchain network. At the same time, the change of the local database will directly start the conditions in the computer code to execute the relevant processes, that is, the driving mechanism, which can ensure that the process is not disturbed by individual uncertainties (Sturm et al. 2019). In addition, smart contracts can also improve the automation of various processes in the supply chain, and improve the visibility of the supply chain through real-time monitoring of products and services (Helo and Hao 2019).

At the same time, one of the benefits of blockchain for supply chain management lies in the integration and intelligence of the supply chain (Chang and Chen 2020). A major pain point of supply chain management is the opacity of information. The application of blockchain can contribute to information and improve the trust between nodes (Sharma, Kumar, and park 2019). Each node of the supply chain can achieve its strategic objectives through the integration of blockchain technology and business. In other words, the blockchain can combine more business models, bring innovation and disintermediation to enterprises at each node of the supply chain, and achieve high

transparency, high security and high privacy of information between enterprises. To a certain extent, these measures can reduce the damage of external factors to the trust between enterprises (Nowiński and Kozma 2017). Similarly, based on the application of blockchain, the redesign and optimization of blockchain processes can effectively reduce transaction costs and improve overall performance through synchronous ledger (Schmidt and Wagner 2019).

Finally, in the process of supply chain management, the application of blockchain technology can also improve the sustainability of the organization and the construction of a green supply chain (Dutta et al. 2020). In addition, the blockchain can help the supply chain to conduct reverse product return management, track the location of goods, improve operational efficiency, reduce material waste, and realize the secondary utilization or remanufacturing of obsolete products or recycled products, to achieve sustainable reverse logistics and circular economy, and respond to the United Nations Sustainable Development goals (Dutta et al. 2020). In detail, the blockchain must pass the triple bottom line standard before ensuring that goods are delivered, to achieve efficient return management (Dutta, Choi, et al. 2020). In addition, in the supply chain of the food industry, the implementation of the blockchain can reduce the waste of food, and the use of smart contracts can also ensure the safety of food by sharing real-time information about all food (Kamble, Gunasekaran, and Sharma 2020).

Although the technology of the blockchain can manage the information of the supply chain and the product life cycle, prevent the internal data of the supply chain from being tampered with, and audit and track the accounts of the supply chain, it is still difficult for the blockchain to solve the trust problems related to the data. Although the reputation system can effectively solve the trust problem, the blockchain lacks granularity and automation in the application of the supply chain, and the observation ability is very poor. Therefore, the reputation system cannot be widely used in the supply chain through the blockchain (Malik et al. 2019).

In addition, there are still many limitations in the practical application of blockchain in the supply chain:

1.Scalability

The blockchain will handle the negative impact brought by the increase in the number of users. The increase in the number of transactions and the expansion of the transaction volume will lead to a slower response speed of the blockchain and higher processing costs (Kumar and Tripathi 2020).

2.Privacy

The public blockchain will store data and privacy information as a public ledger, which will lead to the leakage of data privacy in the process of data management and storage, resulting in insufficient confidentiality, thus posing a challenge to information security (Casino, Dasaklis, and Patsakis 2019).

3.Interoperability

Like the root cause of the scalability problem, a large number of information exchanges and the application of blockchain to information in different systems have led to the deterioration of interoperability due to the increase of blockchain applications and numbers (Kumar and Tripathi 2020).

4.Product provenance

Product source refers to the history, source, traceability and other relevant information of products in the blockchain. It is a challenge for this blockchain important information to be presented to enterprises and stakeholders reliably and accurately (O'Leary 2019).

Latency

Similarly, in the face of the increase in the number of transactions, the transaction of orders and the processing time of bitcoin blocks are affected by the substantial increase in the number of transactions, which leads to the slow speed of the blockchain architecture in processing these orders, thus bringing a delay challenge (O'Leary 2019).

Auditing

Auditability is the key to ensure that goods are easier to track. Visibility and disintermediation are the unique advantages of blockchain technology. In order to ensure these advantages, the importance of auditability cannot be ignored. In the absence of intermediary intervention, if the auditability of orders cannot be guaranteed, the credibility of transactions will be continuously reduced (Dutta et al. 2020).

Conclusion

Based on the review of the existing literature, the related concepts and technologies of Supply Chain Intelligence and Industry 4.0 are elaborated in detail, which is applicable to promote the intelligent reform of each node in the supply chain. Through the knowledge expansion of related concepts, it provides a theoretical basis for the next research. Scholars believe that under the background of Industry 4.0, the benefits of supply chain intelligence to supply chain management are obvious, which are reflected in improving the flexibility, visibility, security and timeliness of the supply chain. However, scholars also believe that the intelligent process of the supply chain will bring some risks and challenges to enterprises, such as data security, customer privacy, etc. These documents and materials can help to conduct more comprehensive and critical research in the following research.

There are research gaps in the existing literature. Although the supply chain intelligent reform and ancillary technologies are widely mentioned, most of them are targeted at large enterprises with strong financial or scientific and technological strength. It is still blank for small and medium-sized enterprises to realize the intelligent reform of the supply chain. However, the proportion of small and medium-sized enterprises in enterprises is very high. Therefore, it is necessary to study how to promote the intelligent process of the supply chain of small and medium-sized enterprises.

Chapter 4 Research Questions

In the past research, many researchers have shown the achievements of the technologies involved in the intelligent reform of the supply chain, such as big data, the Internet of Things, artificial intelligence and so on. Among them, some scholars elaborated on the advantages of the intelligent reform of the supply chain for enterprises. Scholars began to realize that the intelligent reform of the supply chain is the future development direction of the supply chain. In the daily operation of enterprises, the intelligent management of the supply chain brings more and more competitive advantages. However, most of the relevant research results show a discrete state, that is, scholars often only study a certain technology under the background of Industry 4.0 or integrate and apply a certain two technologies, and few studies systematically describe how enterprises carry out supply chain reform, and few studies or reports provide a systematic reform framework for enterprises to carry out supply chain intelligent reform in detail. Secondly, for the current research results, these research results can only be applied to the reform of large enterprises in most cases. For small and medium-sized enterprises, due to their weak economic capacity and lack of relevant majors, these research results have great limitations in helping small and medium-sized enterprises to

succeed, This is why these research results have brought little help to small and medium-sized enterprises. In addition, it is difficult for small and medium-sized enterprises to rely solely on the current research results and successful cases of large-scale enterprise reform, because behind the success of large-scale enterprise supply chain intelligence reform, there are often basic conditions that other small and medium-sized enterprises do not have, and the comprehensive strength of large-scale enterprises and small and medium-sized enterprises is completely different, Therefore, according to the existing reports and examples, it is difficult to make substantive contributions to the reform and development of SMEs themselves.

Since COVID-19 has seriously affected the efficiency of the supply chain after its global spread, countries have implemented different isolation policies, resulting in the supply stability and reliability of goods and products becoming a challenge to the supply chain in the short term (Francis 2020). In addition, the war between Russia and Ukraine led to a sharp decline in Ukraine's grain exports as a European granary, which led to a global food crisis. For the food supply chain, after the negative impact of COVID-19, the conflict between Ukraine and Russia will undoubtedly expand the scope of the negative impact. The affected parts include production, manufacturing, procurement, processing and logistics. Like the butterfly effect, the conflict between Russia and Ukraine has led to a sharp rise in food prices, At the same time, it also has a serious impact on countries and regions that regard Ukraine as a major food importer (Jagtap et al. 2022). In the turbulent environment, the shortcomings of the traditional supply chain are exposed. Therefore, a stable and timely supply chain is very important to all major enterprises in the world. A stable supply chain can bring enterprises sufficient competitive advantages in the era of rapid economic development.

In the current complex world situation, the rapid updating of high-tech research results can bring great changes to the supply chain. Therefore, the past research may not be able to apply the current high-tech to enterprises and supply chains. Therefore, this dissertation hopes to further apply high-tech under the background of industry 4.0 to the supply chain and to help small and medium-sized enterprises in the process of intelligent supply chain. To achieve this research purpose, this discussion will conduct qualitative research on recent studies, to determine which technologies can be more suitable for small and medium-sized enterprises and can bring advantages to small and medium-sized enterprises. Specifically, the following stages will be used in this section to determine which technologies are suitable for SMEs and which technologies can bring them competitive advantages.

The following are the research questions of the dispersion

First, at the stage of data collection, why do scholars think that the supply chain should be intelligent? What technologies can promote the intelligence of the supply chain? What areas of the supply chain do these technologies involve?

Secondly, in the data analysis stage, what are the advantages of Supply Chain Intelligence for enterprises? How can these advantages improve the company's environmental performance, economic performance and social performance? What are the advantages of the intelligent supply chain over the traditional supply chain?

Finally, the suggestion stage will end. How can supply chain intelligence help enterprises cope with the current situation? How can intelligent supply chain be applied to small and medium-sized enterprises? How should small

and medium-sized enterprises use and learn from the experience and relevant theories of intelligent supply chain of large enterprises, to promote the intelligence of their own supply chain?

The research on these issues is a combination of theory and practice, so it is of great significance to realize the research purpose of this dissertation. In this division, these research questions are all step by step. In the data collection stage, we explain the necessity of supply chain intelligence and related technologies, as well as which performance of the supply chain can be targeted by such technologies. Then, in the data analysis stage, we can more specifically describe the advantages that supply chain intelligence brings to enterprises and how to bring them, Finally, the conclusions based on the above analysis will bring suggestions for the intelligent reform of small and medium-sized enterprises. Therefore, these research questions and research orders are reasonable. In terms of theory, this division will discuss the importance and necessity of supply chain intelligence. As a technical means to overcome the shortcomings of traditional supply chains, supply chain intelligence will widely attract the research and attention of relevant scholars in the field of the supply chain, and the intelligent process of the supply chain will be the answer to the challenges brought by various uncertain factors in the future production process of the global supply chain. In addition, for the pain points of the traditional supply chain, such as the bullwhip effect, the intelligence of the supply chain can also bring answers to this problem through its unique advantages, to solve the long-term problems that have plagued the traditional supply chain. From the perspective of practice, the research on supply chain intelligence in this section can help small and medium-sized enterprises speed up the process of supply chain intelligence, to help small and medium-sized enterprises seize opportunities and overcome challenges in the turbulent market environment in the future. The technological achievements brought by Industry 4.0 are affecting the supply chain extensively and will bring great changes to the reform of the supply chain. This dispersion can also bring some effective suggestions to enterprises, help enterprises to focus on the reform according to their own basic conditions, and help enterprises to achieve the automation of the supply chain as soon as possible.

Chapter 5 Research Method & Design

Research Methods

To explore the advantages brought by supply chain intelligence, this discussion adopted the qualitative analysis research method. Because of the industry 4.0 related technologies mentioned in the literature review, it analyzed how enterprises carry out intelligent supply chain reform from different technical fields and analyzes the reasons for intelligent supply chain reform, The mode of Supply Chain Intelligent reform and the results of Supply Chain Intelligent reform analyzed from three perspectives. The reason why qualitative analysis was selected in this discussion was that qualitative analysis could explain in simple words how the technology of Industry 4.0 can promote the intelligent process of supply chain and the advantages that intelligence brings to enterprises through a general description of complex theory(Ochoa and Merceron 2018). If the quantitative analysis method was used, it was difficult to give general suggestions when the comprehensive strength of each enterprise was different. Limited by the economic strength, scientific and technological strength, consciousness and other factors of enterprises of different sizes, there were huge differences between the data, which led to the lack of representativeness of the research and the lack of rigour in the conclusion. In addition, the qualitative analysis method was relatively easier to carry out, and the data collected in this discussion on the reform of supply chain intelligence could help future researchers to more easily continue to study related issues about supply chain intelligence.

Research Objectives

This discourse selected the literature and company reports in the past ten years as the analysis targets, to determine which aspects of intelligent management of supply chain could improve the performance of enterprises. In recent years, the occurrence of COVID-19, the Sino-U.S. trade war, Russian Russian-Ukrainian conflict and other events had brought great impact on supply chain management. Therefore, taking ten years as a time node for selecting data can more accurately reflect the impact of various hot supply chain events on Supply Chain Intelligence in recent years. At the same time, for the company's reports and documents in the past ten years, its advantage over earlier documents and reports is that the technology brought by Industry 4.0 is relatively more mature. Because it took a cycle from development to successful application of a new technology. Due to the immaturity of technology application or the application of technology in inappropriate fields, there may be a large gap between the data of ten years ago and the data of the past ten years. Therefore, the conclusions drawn from the analysis of data from ten years ago are not representative.

Data collection

This dissertation uses the annual reports of Google Scholars and major enterprises over the past decade as data. The standard for screening data is to publish the documents, reports and journals titled "Supply Chain Management", "Industry 4.0" and "Supply Chain Intelligent Management" in the past decade because these documents can bring more samples to dispersion. At the same time, the reason for using "industry4.0" as the keyword is that the technologies involved in supply chain intelligence are basically the same as those involved in industry4.0. Therefore, "industry 4.0" is also an important reference for high-tech research achievements such as "big data", "artificial intelligence", and "Internet of Things". In addition, during the data screening process, to determine the quality of references, reduce the impact of loose or low-quality documents on the final results of this interpretation, and ensure that the final research results of this interpretation are rigorous and effective, we also consulted ABDC as the secondary screening standard. Based on the above criteria for data screening, 40 relevant literatures were collected as data samples for secondary analysis.

Processing data

NVivo 12 was used as the data processing tool in this discourse. Because this dissertation used the research method of qualitative analysis, NVivo 12 could effectively analyze different types of data, such as text, pictures and audio. NVivo 12 is the most suitable research tool for qualitative research. Nvivo12 could help in the classification, sorting and sorting of data, and can help the interpretation to more efficiently establish models and count word frequency(“Learn More About Data Analysis Software | NVivo” n.d.). The analysis report was displayed in the form of pictures, which ensured that readers could more easily understand the content of this interpretation, and also facilitated the collation and intuitive display of the collected data. In addition, the use of NVivo 12 could also ensure the validity of data. NVivo 12 could reorganize synonyms or words with similar meanings and classify them into a unified vocabulary. Finally, nvivo12 could use node analysis tools, which means that the correlation between the data and the implicit internal relations could be intuitively displayed, bringing enough basic samples and data for further research and analysis.

Content analysis

After nvivo12 was used to process and analyze the data, this dissertation recorded and displayed the processing results in Chapter 6. Through further analysis of the word frequency analysis results, this dissertation could analyze the advantages of supply chain intelligence over supply chain, and could more intuitively draw what types of technologies could improve what types of performance in what ways. For example, big data analysis can predict future market demand through the collection of customer purchase information, and centralized procurement of goods with increasing demand in advance can reduce the purchase of goods with decreasing demand in the future, so as to improve income and reduce inventory costs, and ultimately improve economic performance. In addition, the results of node analysis used NVivo12 in this dissertation could be used to analyze the implicit relationship between technology and cost. For example, for the application of the Internet of Things, the cost is relatively low but the income is relatively high. At the suggestion stage, the reformed scheme and reformed technology more suitable for small and medium-sized enterprises can be selected for the supply chain intellectualization process of small and medium-sized enterprises.

Obtaining Findings

After completing the analysis of the data, this dissertation referred to the conclusions of the node analysis to provide SMEs with a supply chain intelligent reform framework that conforms to their basic capabilities and could effectively use the research results of this dissertation in the daily production process of SMEs, to help SMEs bring certain competitive advantages in the difficult period after the COVID-19 epidemic. For large enterprises, the analysis of relevant technologies of industry4.0 in this dissertation could help them to surgically carry out precise reform of the supply chain structure because of internal problems within the enterprise, to reduce the negative impact of global events such as COVID-19 and the conflict between Russia and Ukraine.

Chapter 6 Data Collection & Analysis

Data collection

To explore what advantages supply chain intelligence will bring to the supply chain, this dissertation used qualitative research on the current research. The analysis of the literature discusses how supply chain intelligence can help the supply chain and what competitive advantages it will bring to the supply chain. On the basis of the literature selection criteria in Chapter 5 "Methodology", this division again eliminated the repetitive research and irrelevant research and finally obtained 40 articles related to supply chain intelligence. The forty literatures are numbered and sorted from 1-40 and displayed in the appendix at the end of the dispersion. These documents are compiled in Appendix A.

Next, the research contents and conclusions of this literature will be briefly summarized:

Data analysis

Descriptive analysis of word frequency statistics

Figure 1 shows the keywords repeatedly mentioned in the selected article. By deleting some common words that do not express important information, such as year and "supply chain management", some nouns that have no substantive meaning but are widely mentioned. In addition, in the process of using NVIVO 12, to ensure a higher degree of visualization and simplicity of the samples, synonyms are classified and the results in Figure 1 are finally obtained. This shows that in the past ten years, most studies have mentioned data, blockchain and technology, which

means that the technology of industry 4.0 has begun to be widely studied and applied to the production process of enterprises. Industry 4.0 is a broad concept, which also includes several sub-concepts: intelligent factory, network physical system, new distribution and procurement system, new distribution and procurement system, adapting to human needs, corporate social responsibility, and self-organization (Lasi et al. 2014).

Figure 1

(Made by Author with NVIVO version 12)

data	4	6316	0.56	data, data', data'spotential, data'svalue, inform, informal, information, informational, informative, informed, informing, informs
technology	10	3176	0.34	engin, engine, engineer, engineered, engineering, engineers, engineers', engines, technic, technical, technicalities, technically, technolog, technological, technologically, technologies, technologies', technology
blockchain	10	1291	0.30	blockchain, blockchain'', blockchained, blockchains
industry	8	3674	0.25	diligence, diligently, energetics, industrial, industrialization, industrialized, industrializing, industrie, industries, industry, manufacturability, manufacture, manufactured, manufacturer, manufacturers, manufacturers', manufactures, manufacturing, manufacturing', manufacturings
digital	7	1064	0.21	digit, digital, digitalisation, digitalise, digitalised, digitalization, digitalize, digitalized, digitalizing, digitally, digitisation, digitise, digitised, digitising, digitization, digitized, digitizes, digitizing, digits, figure, figures
applications	12	1791	0.20	applic, applicability, applicable, applicant, applicants, applicated, application, application', applications, coates, cover, covered, covering, covers, diligence, diligently, pertinent
literature	10	860	0.20	lit, literature, literatures
supply	6	6095	0.20	"cater, 'supply, add, adds, append, cater, catering, furnished, furnishes, issue, issued, issues, issuing, ply, provide, provided, provider, providers, providers', provides, providing, provision,

Table 1

(Made by Author with NVIVO version 12)

In addition, to ensure the accuracy and accuracy of the analysis conclusion and facilitate the readers' interpretation, this paper uses the word frequency statistics tool of NVIVO 12 to record the words with the highest word frequency ranking and puts the results in the appendix. Among them, words with a weighting ratio of more than 0.1% are words that have a significant impact on the conclusion of this discourse analysis. After removing the three keywords "supply", "chain" and "intelligent", the remaining high-frequency words are "data", "technology", "blockchain" and "industry". These five keywords are highly relevant in the current supply chain intelligence research. To simplify the results in the process of using NVIVO12 word frequency statistics, the filtering method of "synonyms" is selected. For example, "information" may be included in "data", and "manufacture" may be included in "industry". See Table 1 for details. Table 1 also contains the length, word frequency, weight percentage and other information of high-frequency words.

Data

Data refers to the information of each node of the supply chain and the information collected by big data analysis. For the supply chain of enterprises, the transparency and circulation of data can largely alleviate the problem of poor information circulation and sharing in the traditional supply chain. It can be seen from Table 1 that the word frequency of data is 6316 times, second only to "supply chain", and the word frequency of data is significantly higher than that of "technology", which is ranked second. This shows that many scholars believe that the intelligent management of the supply chain starts with data, and data can greatly contribute to overcoming the inherent defects of the traditional supply chain.

After the node analysis of the selected 40 articles, this dispersion found that 16 of the 40 articles mentioned data-related content in the abstract, and the number of documents mentioning data accounted for 40% of the total number of documents. Among them, data is mentioned in the abstract of documents numbered 6,7,13,15,16,17,18,25,27,28,30,32,33,34,36,38. The following is a brief description of these documents:

Literature 6 provides specific measures for the design of the supply chain of small and medium-sized enterprises and helps the supply chain to improve flexibility, visibility and reliability. At the same time, the redesign of the supply chain can also help small and medium-sized enterprises to improve their economic performance (Alzoubi and Yanamandra 2020). Literature 7 discusses the application of blockchain to help supply chain in the future market competition, analyzes the disadvantages of traditional supply chain, and expounds that blockchain technology can help traditional supply chain overcome the disadvantages and improve the economic performance of enterprises from four aspects: traceability, visibility, participation in collaboration and supply chain integration (Chang and Chen 2020). Literature 13 studies the advantages of the Internet of Things and Communication Technology (ICT) for the logistics link of the supply chain, such as improving the visibility of the supply chain, the integrity of the supply chain, etc., and puts forward some suggestions according to the problems faced by enterprises, to help enterprises improve performance and flexibility under the guidance of Industry 4.0 technology (Barreto, Amaral, and Pereira 2017). Document 15 describes the advantages of Industry 4.0 technology, Internet technology and traditional industry integration, explains the advantages that big data and cloud computing can bring to upstream and downstream nodes of the supply chain, and also points out the negative effects of some Industry 4.0 technologies, such as complex business processes (Schmidt et al. 2015). Literature 16 pointed out that the traditional supply chain is faced with such defects as high dissertations resources, low information sharing efficiency, and poor agility, and

proposed an intelligent supply chain reform scheme based on the Internet of Things technology, to improve the flexibility of the supply chain and the circulation of information. At the same time, intelligent technology is used to promote the intelligent process of the supply chain, enhance the condition perception of the supply chain, resource services, and so on, to improve the comprehensive strength of enterprises, And bring economic benefits to the enterprise (Yan et al. 2014). Document 17 points out that the digital transformation of the supply chain is a necessary choice, not an alternative, for enterprises to gain more competitive advantages in the future. At the same time, it systematically expounds that the digital transformation of the supply chain can be driven by big data, cloud computing, artificial intelligence, nanotechnology, 3D printing and other high-tech. At the same time, document 17 also points out that digitalization is of great significance to enterprises and stakeholders, The digitalization of the supply chain will affect the economic performance of enterprises and create more opportunities for enterprises in the future (Agrawal and Narain 2018). Literature 18 expounds on the importance of supply chain integration coordination and cooperation with superior and subordinate suppliers and points out that the overall value of the supply chain is greater than the sum of the values of each link. In addition, Literature 18 also points out that information problems are the pain points of traditional supply chains, such as low information reliability and poor information timeliness. Literature 18 helps the supply chain achieve intelligent management through the application of big data and Internet of Things technology, to overcome the drawbacks caused by the bullwhip effect (Jiang 2019). Literature 22 integrates data analysis and supply chain management, and classifies the contributions of technologies in different fields to supply chain management, including big data, artificial intelligence, machine learning and other cutting-edge technologies, to help the supply chain carry out innovative reform, help the supply chain collect information efficiently, and rely on accurate information to bring more scientific basis for decision-making (Awan et al. 2021). Document 25 discusses the defects of the traditional supply chain in the new era, including uncertainty, complexity and vulnerability, and expounds on the importance of the intelligent reform of the supply chain. The application of the Internet of Things in supply chain management, helps the supply chain effectively deal with issues related to information, such as unreliable information, incomplete information, slow circulation and poor timeliness, Thus, through the intelligent process of the supply chain, we can overcome the challenges faced by the traditional supply chain in the turbulent economic environment, and improve the security of the supply chain operation (Abdel Asset, Manogaran, and Mohamed 2018). Literature 27 studies the elasticity of the supply chain and believes that the complexity of the enterprise's supply chain is increasing with the increase of the degree of change in the face of customer demand, which leads to the difficulty of risk management in the supply chain. The redesign of the combination of the Internet of Things and the supply chain can greatly increase the visibility and flexibility of the supply chain, and also improve the quality of products (Al Talib et al. 2020). Literature 28 describes the fundamental reasons for the unreliable information and data of the traditional supply chain. Therefore, literature 28 introduces blockchain technology into the traditional supply chain, hoping to solve the defects of data centralization through the decentralization of blockchain technology, to make the data set more transparent and form a reliable and efficient information management system in the supply chain (Naidu et al. 2018). Literature 30 studied the impact of big data on business, operation management and supply chain management, and redefined big data according to the industry to help the supply chain improve its economic performance and develop long-term reliable partners from four aspects: quantity, speed, diversity and accuracy (Richey et al. 2016). Literature 32 points out that recent scholars have a strong interest in the data analysis of supply chain management, and are committed to studying the application field of supply chain management for big data. It describes what advantages and help supply chain management can bring by relying on big data, and provides a model for the application of big

data in supply chain management to help enterprises achieve a reasonable application of big data (Nguyen et al. 2018). Literature 33 believes that the supply chain is one of the areas that can best reflect the role of the blockchain. Literature 33 uses core ledger data to help store on the chain, and smart contracts to help connect and store data by combining the blockchain with distributed storage, to ensure the authenticity and security of data, make records, and ultimately bring substantial contributions to the information management of the supply chain (Kawaguchi 2019). Literature 34 focuses on the practical application of big data in the field of logistics and supply chain, explores the relationship between big data analysis and supply chain performance, and how big data can be applied to supply chain management maturely to help supply chain and logistics improve their information collection strategies, thus bringing competitive advantages to enterprises in all aspects (Govindan et al. 2018). Literature 36 studies the impact of Industry 4.0-related technologies on supply chain performance. Through the practical application of Industry 4.0 technology in the supply chain, it can improve the performance of the supply chain, help the supply chain to integrate, improve the information sharing ability and transparency of the supply chain, promote the intelligence of the supply chain, and contribute to the improvement of the supply chain ROI from the aspects of procurement, production inventory and sales (Fatorachian and Kazemi 2020). Literature 38 found that the amount of data on the Internet has increased significantly, which brings challenges to supply chain management. This is why the importance of big data business analysis is growing. Literature 38 found that big data business analysis can optimize the supply chain process, strengthen the collaboration between nodes of the supply chain and improve the agility of the supply chain through the integration of big data business analysis and supply chain. In addition, Literature 38 also points out that big data and supply chain analysis can be used as strategic assets of enterprises to help enterprises integrate and analyze their businesses (Wang et al. 2016).

Through a brief description of the literature that mentions data, it can be found that these literature involves big data, the Internet of Things, blockchain, communication technology (ICT) and other fields. Among these 16 literatures, 15, 17, 18, 30, 32, 33, 34 and 38 all mention big data, accounting for 50% of the literature that mentions data. Therefore, according to this result, This paper argues that big data will make a significant contribution to data transparency and sharing.

After further research on these documents, it is found that the factors influencing data visibility and sharing degree come from many aspects, such as poor traceability of goods in the supply chain, lack of trust between nodes and partners in the supply chain, poor supply chain collaboration (Chang and Chen 2020), highly dissertations resources, poor condition awareness (Yan et al. 2014), and poor reliability of information collection (Jiang 2019), The efficiency of information collection is low (Awan et al. 2021), the risks faced by the supply chain due to drastic changes in customer demand are increasing (Al Talib et al. 2020), the security and privacy of data are poor (Kawaguchi 2019), and the amount of information is increasing significantly (Wang et al. 2016). Therefore, the solution to data visibility is a composite problem, rather than a single technical means.

The solutions to the poor visibility of the supply chain mainly come from the following aspects: redesign the supply chain, optimize the process (Alzoubi and Yanamandra 2020), strengthen the security and privacy of the data through the application of the blockchain and the characteristics of blockchain decentralization, prevent the data from being tampered with (Naidu et al. 2018), and use the blockchain to enhance the traceability of goods, Ensure the timeliness and accuracy of information (Chang and Chen 2020), and integrate the blockchain with distributed storage to further

strengthen data security and ensure the authenticity of information (Kawaguchi 2019). Then, for the application of big data, we can make more scientific predictions of future market changes and customer demand changes through big data to ensure the accuracy and timeliness of information (Govindan et al. 2018). At the same time, the application of big data can accurately identify effective data in the huge database, thus improving the efficiency of data screening and improving the reliability of data (Wang et al. 2016). Finally, the application of the Internet of Things. The combination of the Internet of Things and communication technology (ICT) can significantly improve the visibility of the supply chain (Barreto, Amaral, and Pereira 2017). The integration of the Internet of Things and the supply chain can also increase the visibility and flexibility of the supply chain data (Abdel Asset, Manogaran, and Mohamed 2018), overcome the problem of slow information flow and lack of timeliness, and effectively improve the quality of products (Al Talib et al. 2020), In addition, the integration of big data and the Internet of Things can also help the supply chain achieve intelligent management of information, bring advantages to the visibility of information, and solve the challenges posed by the bullwhip effect (Jiang 2019). However, some literature also mentioned the drawbacks of the integration of Industry 4.0 technology and supply chain management, such as too cumbersome and complex business processes (Schmidt et al. 2015), the significant increase in data volume, and so on (Wang et al. 2016).

Afterword frequency analysis and node analysis of literature and data samples in the past 10 years, this dispersion believes that although the visibility of data has been a difficult problem that has plagued the traditional supply chain, enterprises can apply the Industry 4.0 technology, such as the Internet of Things, big data and blockchain, from data sources, data processing, Data forecasting and data analysis are used to solve the problem of data visibility in the supply chain. The application of these technologies can not only promote the intelligent reform of the supply chain but also effectively improve economic performance (Fatorachian and Kazemi 2020), (Yan et al. 2014). Although the effective application of these technologies can bring advantages to the data visibility of the supply chain, enterprises still need to make selective technology applications according to their comprehensive strength and the problems they face. Excessive high-tech superposition will bring complex business processes (Schmidt et al. 2015) and huge data processing workloads (Wang et al. 2016).

Technology

In supply chain intelligence, the technology involves a wide range of fields, including various high-tech application achievements brought by Industry 4.0, such as big data, blockchain, Internet of Things, cloud computing, etc. The application of high and new technology is of great significance to the intelligent process of the supply chain. After the word frequency query, it is found that the word frequency of technology has reached 3176 times. This result shows that in the research on supply chain intelligence in the past decade, except for the research on data, most of the research is focused on the application of technology. Similarly, such data analysis results also prove the importance of technology application in the process of supply chain intelligence and the degree of attention paid by scholars to the practical application of technology.

After the node analysis of 40 selected articles, 27 articles mentioned the application of technology. At the same time, the 27 articles on technology application and data show a high degree of repeatability, which indicates that the use of a large number of technologies is mainly to solve the problem of data visibility in the supply chain, which is consistent with the research results in the "data" section. After removing the documents partially overlapping with

"data", there are 17 documents, namely, 1, 2, 3, 4, 8, 9, 10, 11, 19, 20, 21, 22, 23, 24, 26, 29, 33, which separately mention the application of technology. Here is a brief description of these documents:

Literature 1 studied the Internet of Things and proposed an intelligent supply chain management system integrated with the Internet of Things and cloud computing to track and manage goods in real time for suppliers and customers (Fore et al. 2016). Literature 2 studies the wireless communication system RFID in the Internet of Things. Through the optimization of RFID technology, it identifies the key factors that affect the efficiency of the supply chain and effectively improves the efficiency of the supply chain (Chen et al. 2021). Literature 3 has studied machine learning. It optimizes the production process through the optimization of machine learning in the factory, saves energy, time and resources through machine learning, and contributes to improving the environmental and economic performance of enterprises (Weichert et al. 2019). Literature 4 studies that the supply chain has become more complex, uncertain and vulnerable under the background of the accelerated process of economic globalization. Through the application of integrated optimization of the supply chain process, intelligent decision-making, intelligent risk management and intelligent supply chain collaboration, enterprises can solve the market shock caused by economic globalization (Zhao, Ji, and Feng 2020). Document 8 describes the related issues of supply chain risk management, and studies how to improve the control over supply chain risk management through artificial intelligence and machine learning. In addition, document 8 also proposes a systematic framework to help enterprises choose the type of machine learning, thereby helping enterprises improve the scientific nature of decision-making (Deiva Ganesh and Kalpana 2022). Literature 9 studies the current situation of blockchain technology and application and describes how blockchain technology can subvert traditional industries. In addition, Literature 9 also classifies the application scope of blockchain, including supply chain, Internet of Things and data management (Casino, Dasaklis, and Patsakis 2019). Literature 10 studies the related technologies of industry 4.0, and finds that the application of technology brought by industry 4.0 is highly correlated with the improvement of economic performance of enterprises. The technology and products of Industry 4.0 can bring competitive advantages to enterprises in terms of operation and marginal utility (Dalenogare et al. 2018). Literature 11 also studies Industry 4.0, but it starts from the perspective of sustainable development from the application of Industry 4.0 technology. In other words, the research result of literature 11 is that the technology of Industry 4.0 can improve the environmental performance of enterprises. At the same time, because different industries have different technical characteristics and industry characteristics, Document 11 gives suggestions on the application of Industry 4.0 technology for different industries, and evaluates how enterprises can improve their environmental and social performance (Bai et al. 2020). Literature 19 discusses how to protect the information security of the intelligent supply chain and risk management in related fields from the perspective of technology. Through the summary and analysis of the supply chain risk identification technology from 1980 to 2020, it determines the defects of the past risk identification technology and optimizes the risk identification process based on the current technology, To ensure the network information security and information privacy of the intelligent supply chain (Abouterab et al. 2021). Literature 20 describes the role of AI in supply chain management, and how AI can promote the process of supply chain intelligence. Literature 20 discusses, for example, how AI can help decision-makers make scientific decisions, the application fields of AI in the process of supply chain management, or under what circumstances AI can be used to help supply chain management (Pourader et al. 2021). For the logistics link in the supply chain, Document 21 provides systematic technical support through IT and then integrates logistics and supply chain management to achieve business intelligence and help decision-making. In addition, Document 21 also provides two specific application cases of supply chain intelligence

for enterprises and research (Haas 2019). Literature 22 integrates data analysis and supply chain management and classifies the contributions of technologies in different fields to supply chain management, including big data, artificial intelligence, machine learning and other cutting-edge technologies, so as to help the supply chain carry out innovative reform, help the supply chain collect information efficiently, and rely on accurate information to bring more scientific basis for decision-making (Awan et al. 2021). Literature 23, from the perspective of artificial intelligence, points out that the supply chain will be greatly changed in the future under the influence of artificial intelligence. In Literature 23, the value of artificial intelligence in the supply chain is evaluated, and the value field of artificial intelligence in the supply chain is determined (Helo and Hao 2021). Literature 24 indicates that the traditional supply chain is difficult to adapt to today's fierce competition environment. Research has been conducted on the contribution of AI to the reform of the supply chain, including machine learning and natural language processing. Finally, suggestions and frameworks have been provided for the full application of AI technology in the supply chain (Riahi et al. 2021). Literature 26 has studied the sustainable supply chain, closed-loop supply chain, enterprise planning resources and the Internet of Things. Literature 26 believes that in today's volatile market, it is increasingly difficult to predict customer demand. Literature 26 is committed to embedding the Internet of Things into the supply chain so that enterprises can better adapt to the changes brought about by the fourth industrial revolution. In addition, literature 26 also provides organizations with evaluation criteria for transformation preparation conditions, To help organizations achieve better intelligent transformation (Manavalan and Jayakrishna 2019). Literature 29 found more challenges for the supply chain in the field of rapid consumption under the world pattern of COVID-19. Through the application of the Internet of Things, Literature 29 hopes to help the supply chain operate more smoothly, help the operation and business activities become intelligent, and provide improvement measures and incentives for the intelligent process of the supply chain (Kon č ar et al. 2020). Literature 33 believes that the supply chain is one of the areas that can best reflect the role of the blockchain. Literature 33 uses core ledger data to help store on the chain, and smart contracts to help store and connect data, so as to ensure the authenticity and security of data, make records, and ultimately bring substantial contributions to the information management of the supply chain (Kawaguchi 2019).

After further analysis of the selected literature, it is found that the contribution of new technologies to the reform of the supply chain comes from many aspects. In the direct research on technology applications, there are 10 papers dedicated to solving the problem of poor information transparency in the supply chain. Among the other 17 documents, documents 1, 2, 9, 26 and 29 focus on the research of the Internet of Things technology. The research conclusion is: that through the integration of the Internet of Things and cloud computing, the traceability and management of goods are strengthened (Fore et al. 2016), and the optimization and application of RFID technology in the Internet of Things improve the efficiency of the supply chain (Chen et al. 2021), Through the application of the Internet of Things, we can promote the intelligence of supply chain management (Kon č ar et al. 2020) and strengthen the information management level of the supply chain (Casino, Dasaklis, and Patsakis 2019). In addition, literature 3, 8, 20, 22, 23 and 24 studied the application of artificial intelligence and machine learning in the supply chain. The conclusion is: optimize the production process, save resources and reduce costs through machine learning (Weichert et al. 2019), determine the value of artificial intelligence in the supply chain (Pourader et al. 2021) (Awan et al. 2021), and improve the scientific nature of enterprise decision-making (Deiva Ganesh and Kalpana 2022) (Pourader et al. 2021), It also brings suggestions and frameworks for enterprises to rationally use AI and machine learning technologies (Riahi et al. 2021).

After analyzing the sample data of the past decade, this dispersion found that the adoption of new technologies brought about by Industry 4.0 is an important means to improve economic performance, especially the application of the Internet of Things and artificial intelligence is of great significance for the improvement of economic performance. However, in the process of data analysis, this dispersion found that improving economic performance is not the only purpose of using new technologies. The reason for using high-tech is to solve the problem of information visibility in the supply chain.

Blockchain

As a proper name, blockchain is widely mentioned in these reports, which further proves the importance of blockchain for intelligent management of the supply chain. As one of the technologies of Industry 4.0, blockchain is almost identical to the "technology" part. The number of documents that mention blockchain in the abstract is 7,9,28,33. However, as the noun with the least synonyms in the word frequency statistics, it has been mentioned 1291 times, which shows that in the process of supply chain intelligence, blockchain is far more important than other technologies. At the same time, this dispersion also found that the documents referring to blockchain also highly overlap with the documents in the "data" section, which means that in the process of intelligent supply chain, the application of blockchain is mainly to solve the problem of data visibility.

After further research on the literature mentioned in the study, it is found that the contribution of blockchain to information visualization is mainly to solve the problem of highly centralized information in the supply chain through its decentralized characteristics (Naidu et al. 2018), to decentralize highly centralized information and improve the speed of information circulation. In addition, blockchain can also combine distributed storage with core ledgers, chain storage, smart contracts and other methods help to store information and prevent information from being tampered with, thus ensuring the security and privacy of information (Kawaguchi 2019).

According to the node analysis of research reports in the recent ten years, this dispersion determines the importance of blockchain for supply chain intelligence and also identifies the key role of blockchain for supply chain information visibility. Enterprises can start to reform the traditional supply chain from the specific application of the blockchain. Through the unique advantages of the blockchain, enterprises can solve the problem of information circulation, achieve intelligent management of the supply chain, and bring more economic benefits to enterprises.

Industry

"Industry" in this article mainly includes two elements: "industry4.0" and "manufacture". In the word frequency analysis, industry has appeared 3674 times, which is second only to "data". This means that Industry 4.0 and manufacturing are also the main research objects on the intelligent process of supply chain in the past decade. "Industry 4.0" mainly refers to the fourth industrial revolution. Most of the contents related to "Industry 4.0" in this dispersion are related to the technology of Industry 4.0. Therefore, the contents related to Industry 4.0 completely coincide with the literature on technology and blockchain. This dispersion does not discuss Industry 4.0 separately but focuses on the literature referring to manufacturing. It can be concluded from the frequency of production that scholars believe that production is the most important link in the supply chain because the results of word frequency statistics show that the frequency of keywords such as purchase, sales and operation in other nodes of the supply

chain is far lower than that of production. Therefore, this dispersion believes that production is one of the main objects that scholars focus on in the process of supply chain intelligence.

However, the results of node analysis show that even if the keyword "industry4.0" is excluded, the manufacturing and technology parts still have a clear correlation. In other words, the application of technology is basically for manufacturing, such as intelligent production and improving production efficiency and product quality. For example, Document 3 refers to improving production efficiency through artificial intelligence and machine learning (Weichert et al. 2019), Document 27 studies the application of the Internet of Things to the supply chain to improve product quality (Al Talib et al. 2020), and Document 36 refers to the application of industry 4.0 related technologies to improve the production capacity of the production line (Fatorachian and Kazemi 2020). It can be seen that the visibility of "data", the efficient production of "manufacture" and the high quality of products are the purposes of the application of "technology", including "blockchain", in the supply chain.

Chapter 7 Research Findings &Suggestions

Research findings

The results of this research on 40 pieces of literature show that in the last ten years, scholars' research on intelligent management of supply chain has mainly focused on the application of Industry 4.0 technology, to improve information transparency and supply chain flexibility, and finally greatly improve the performance of enterprises.

After the analysis of "data", the results show that the research in the past decade believes that data transparency is an important method to effectively improve the performance of the supply chain, and the effective improvement of data visibility and reliability can reduce the risk for supply chain management. In addition, the transparency of data can directly bring a positive impact on the traditional pain points of the supply chain, especially in today's rapid economic development. For small and medium-sized enterprises, the visibility of the supply chain directly determines the gap in supply chain management capabilities between small and medium-sized enterprises and large enterprises. Improving the reliability and effectiveness of data is an effective means to bridge the gap between small and medium-sized enterprises and large enterprises.

The research on "technology" shows that the intelligent reform of the supply chain needs to rely on the application of Industry 4.0 technology, including big data, artificial intelligence, the Internet of Things and machine learning. At the same time, the research results show that the main purpose of the application of Industry 4.0 technology is to solve the problem of information transparency, followed by improving production efficiency and performance. Although the massive application of Industry 4.0 technology can bring a series of competitive advantages to enterprises, the energy consumption brought about by the related technologies of Industry 4.0 is also far higher than that of traditional supply chain technologies. Therefore, as an enterprise that wants to improve environmental performance, it should balance the relationship between the energy consumption brought about by the application of a large number of new and high technologies and the improvement of environmental performance.

As a branch of "technology", "blockchain" has been extensively studied by scholars, which shows that it is of great significance for the intelligent management of the supply chain. The application of "blockchain" technology can realize "decentralization" and effectively avoid the disadvantage of highly centralized information in the traditional supply chain, which is also an effective method to improve the speed of information circulation in the supply chain.

"Blockchain" can also provide answers to the problems of low information security in the information age. Blockchain's unique information storage mechanism can also prevent information from being tampered with, resulting in a series of privacy leaks or data security problems.

After analyzing "industry", it is found that manufacturing is one of the main reform directions of supply chain intelligence reform to improve performance. Intelligent production can bring efficient production lines to organizations or enterprises. Improving production efficiency means that performance can also increase. In addition, intelligent production can bring more guarantees for product quality.

Suggestions

Based on the previous research conclusions, it can be found that "technology" is the way of reform, "data" and "manufacture" are the purposes of reform, and "technology" is used to ensure the transparency and reliability of information, as well as the efficiency of production and the high quality of products. Therefore, according to the conclusions of the above data analysis, This division will provide reform direction for intelligent reform of small and medium-sized enterprises around "data", "technology" and "manufacture".

Reform direction

Start with data transparency

The fundamental reason for the lack of transparency and reliability of SME data is the lack of methods and awareness of effective data collection. Small and medium-sized enterprises can collect, screen and analyze data through the application of big data, to ensure the completeness of information sets in the supply chain. Then, they can use big data for secondary analysis, screen useful data, eliminate the number of unrelated samples, and improve the readability and practicality of data. Finally, through the application of "blockchain" technology, we can realize the real-time storage of data, ensure the reliability of data, and avoid the risk of data leakage.

Apply new technologies according to their own economic strength

Small and medium-sized enterprises often lack the financial resources and R&D capabilities of large enterprises, which can not be overcome in a short time as a weakness of small and medium-sized enterprises compared with large enterprises. Therefore, as a small and medium-sized enterprise, it is difficult to promote the intelligent reform of the supply chain through the application of a series of emerging technologies. Small and medium-sized enterprises must balance the relationship between the economic benefits and consumption costs of technology applications in the selection of high-tech. Before applying high and new technologies, enterprises can make targeted choices based on their own weaknesses, such as low production efficiency, machine learning or artificial intelligence can be used to improve production efficiency to achieve intelligent production. Blindly adopting high and new technology will bring huge energy consumption and construction costs. As a small and medium-sized enterprise, blind reform is not desirable.

Enhance professionalism

The comprehensiveness of the business field of small and medium-sized enterprises makes it difficult to compete with large enterprises. Therefore, if small and medium-sized enterprises want to obtain more performance by relying on the intelligent reform of the supply chain, they should refine and specialize their business scope. Because SMEs

always play the role of supply chain participants rather than leaders, more specialized reform is more suitable for SMEs, and comprehensive intelligent reform will add more burden to SMEs. For example, Foxconn, as a node in Apple's supply chain, only plays the role of production and assembly, not product design and development. Therefore, small and medium-sized enterprises can learn from the example of Foxconn and give full play to their unique characteristics and advantages, to obtain more performance. Therefore, the intelligent reform of the supply chain should also be more targeted. For example, small and medium-sized enterprises focusing on production can carry out intelligent production reform to give play to their advantages in production; Small and medium-sized enterprises focusing on transportation can apply Internet of Things technology to track and locate goods.

Reform according to the long-term objectives of the enterprise

The development of small and medium-sized enterprises is difficult under COVID-19, so it is very important to formulate long-term strategic objectives and development plans. There are many advantages brought by the intelligent reform of the supply chain, but enterprises should plan based on their future strategic objectives when carrying out the reform, to bring more competitive advantages. Small and medium-sized enterprises are limited by the lack of awareness and knowledge. Therefore, after formulating long-term strategic objectives, they can assign managers or senior managers to carry out systematic learning or communicate with large enterprises, to formulate long-term strategic objectives that meet their own expectations and capabilities. The reform of supply chain intelligence is not only about the reform of hardware facilities or the application of high-tech. For small and medium-sized enterprises, the knowledge and ability of employees are also the key factors to promote the reform of small and medium-sized enterprises. Only the internal managers of small and medium-sized enterprises can be aware of the advantages and disadvantages of the enterprise and can better implement the above-mentioned reforms.

Chapter 8 Conclusion

This dissertation collected the literature, determined the reform direction of supply chain intelligence and the specific technologies involved in the reform process, and determined the substantial help that the supply chain intelligence reform will bring to small and medium-sized enterprises. Through the collection and analysis of literature in the past ten years, this report finds that the purpose of supply chain intelligence reform is mainly to eliminate the information gap, improve the speed of information circulation, visibility and reliability of information, and greatly improve production efficiency and product quality, optimize the production process and reduce human costs. For small and medium-sized enterprises, the intelligent reform of the supply chain can be carried out from the aspects of data visibility, enterprise professionalism and personnel knowledge reserve, to bring significant growth to the performance of small and medium-sized enterprises, including environmental performance, social performance and economic performance.

After considering the process of Industry 4.0 and the application maturity of related technologies, this dissertation makes a qualitative analysis of the relevant literature in the past 10 years, using word frequency analysis, node analysis and content analysis. The analysis results indicate that the academic community pays more attention to how a single technology is applied to the supply chain, and there is not a lot of research on how to integrate these technologies and apply them to the supply chain at the same time, to complete the reform of intelligent supply chain. In other words, a large number of scholars pay more attention to the point-to-point relationship than the point-to-point relationship. In terms of details, scholars are more inclined to study what advantages the Internet of Things can

bring to the supply chain when it is applied to the supply chain, rather than the integration and application of technologies such as the Internet of Things, big data and blockchain in the supply chain. Therefore, a systematic and comprehensive reform plan refers to a more in-depth study in the future.

In addition, under the negative impact of COVID-19, how to survive is the most important issue for enterprises, especially for small and medium-sized enterprises. Therefore, this dissertation gave some suggestions to scholars and small and medium-sized enterprises. First of all, scholars can appropriately expand the scope of research in future research. Although the economic benefits of small and medium-sized enterprises are far lower than those of large enterprises, as the main component with the largest proportion of enterprises, research on small and medium-sized enterprises can bring economic benefits faster. At the same time, the supply chain intelligence reform of small and medium-sized enterprises is less difficult than that of large enterprises, It is also easier for scholars to help the development of small and medium-sized enterprises in the research process. The suggestion for small and medium-sized enterprises is to give priority to pilot reform rather than comprehensive reform in a turbulent environment and take preventive measures for possible risks in the future before reform to avoid bankruptcy of small and medium-sized enterprises due to reform failure.

Chapter 9 Limitations And Expectations

This section has some limitations. In the data collection phase, only a single database is selected for collection, so the selection of samples has some limitations. In addition, in the literature selection stage, some literature was removed from the research scope due to copyright restrictions and lack of access rights so that some representative literature might be missed. In addition, in the process of using Nvivo12, word frequency analysis and node analysis show the research hotspots of scholars in the past decade. However, this kind of analysis intelligence shows the research hotspots to some extent, and the conclusions drawn from the analysis may be missing to some extent, especially under the premise of limited sample data.

As mentioned above, during the research process of this dispersion, it is found that a large number of scholars are studying a single technology, and there are few research reports on the integration and consolidation of multiple technologies. Therefore, this dispersion suggests that the technology of "industry4.0" can be integrated and studied simultaneously in future research. In addition, in future research, scholars can find some representative samples from small and medium-sized enterprises as research objects, to ensure that the research results can benefit small and medium-sized enterprises. Finally, there is the problem of intelligence. The fourth industrial revolution is an opportunity for many industries. Intelligence is not limited to the supply chain. How to apply these high-tech research results to all walks of life is a valuable research direction. For example, artificial intelligence can be used in medicine to perform accurate surgical operations through AI. Similarly, machine learning, as an important branch of artificial intelligence, allows medical personnel to record a large number of cases through machine learning, to ensure that when patients appear, artificial intelligence can quickly and accurately diagnose the characteristics of recorded cases, which will greatly avoid the possibility of misdiagnosis, In addition, it can also avoid miscalculation caused by human factors, such as doctors' empiricism or lack of experience, which ultimately leads to patients missing the best treatment opportunity. However, how to ensure that AI will not make mistakes is a difficult problem to solve in future research. At the same time, how to persuade people that AI will not make mistakes, and how to choose AI for diagnosis instead of doctors is also a problem. Finally, if AI can completely replace the role of

doctors, a large number of doctors will face unemployment, which will lead to a series of social problems. This is also a valuable issue that can be considered in future research.

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