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Overview of the Application of Big Data in Supply Chain Management

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Abstract

Big data has become an important force driving the continuous development of the supply chain. In order to understand the research direction, achievements, and development trends of big data in the field of supply chain management, this article reviews, analyzes, and organizes literature on big data technology and supply chain management at home and abroad, summarizes the research overview at home and abroad, and briefly describes the relevant concepts of big data, big data technology, and big data platforms, Then analyze the application of big data in supply chain management strategic decision-making, supply chain management risk prediction, and improving supply chain management agility; Finally, the shortcomings and future research directions of applying big data to supply chain management are pointed out, providing reference value for relevant scholars to understand the application research of big data in supply chain management.

Keywords

Big Data; Supply Chain Management; Strategic Decision-making; Risk Prediction; Agility.

1. Introduction

In recent decades, with the continuous rapid development of the Internet and information technology, the value of data is also constantly highlighted. Countries around the world regard big data as a strategic resource, and constantly introduce a series of policies and measures to accelerate the development of their own big data [1]. The rapid development of advanced network technologies such as sensors and the Internet of Things has also generated massive amounts of data. The emergence of big data technology has also brought unprecedented opportunities and challenges to logistics supply chain management[2]. The amount of data in big data is enormous and the structure is complex. Currently, conventional mathematical statistical analysis software on the market cannot collect, analyze, and process data within a certain time frame. It needs to be refined and processed to extract valuable data information, which can provide a basis for enterprises to make decisions[3]. Big data, as a series of technologies for data collection, processing, analysis, and intelligent storage, can effectively provide backup technical support for industrial development and enterprise upgrading and transformation. How to extract valuable information from massive data and mine explicit and implicit knowledge for intelligent decision-making and business process optimization has become a key concern for various enterprises. At present, big data related technologies have been widely applied in various fields such as manufacturing, agriculture, and industry. Supply chain management, as a crucial part of enterprise management, utilizing big data to mine the value of production and operation data is of great significance for enterprises to better maximize profits and control costs. The purpose of supply chain management is to improve customer service levels and pursue the overall efficiency of the entire supply chain, rather than minimizing the transportation or inventory costs of a single supply chain member. Therefore, it is necessary to effectively coordinate various supply chain members such as suppliers,

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manufacturers, retailers, and consumers, so as to ensure the smooth operation of the entire supply chain system[4]. In supply chain management, a large amount of data is generated every second, resulting in the collection and recording of many datasets in the supply chain, and the diversity and repeatability of data due to the multiple sources and heterogeneous formats of data[5]. Fast processing of datasets is important, and this speed depends on multiple factors such as the dimensions of the dataset, the efficiency of data storage, the speed of data transmission, and the speed of finding useful knowledge [6]. Big data has characteristics such as scarcity, uncertainty, and diversity, making it difficult to extract value from big data. At present, the application of big data in supply chain management is still in its initial stage. With the continuous development of the supply chain, big data technology contains enormous development potential in supply chain management.

According to the search results of domestic and foreign literature, the research of domestic and foreign scholars mainly focuses on big data technology and supply chain management, and domestic scholars have more research on supply chain management than foreign scholars. Among them, there are many mature studies on supply chain management strategic decision-making, supply chain management risk prediction, and improving supply chain management agility. Therefore, this article will analyze based on this. This article first provides a brief summary of big data, big data technology, and platform concepts. Then, it summarizes the three applications of big data in supply chain management, and proposes future research prospects.

2. Concepts Related to Big Data

2.1. Big Data

The concept of big data was first proposed by McKinsey in 2011 at the Global Research Institute. He believed that "data has penetrated into every industry and business functional area today, becoming an important production factor.". The Global Internet Data Center points out that in the next few years, the total amount of global data will reach a new historical height. From the perspective of the supply chain, big data is a method of overall management that analyzes quantity, variety, speed, accuracy, and value, in order to provide feasible methods for measuring performance and establishing competitive advantages[8].

Big data includes structured data and unstructured data. Structured data refers to data organized and stored according to a certain data model, with clear data types and relationships, and can be processed and analyzed through computer programs. In computer science, structured data is usually stored in the form of tables, such as tables in relational databases. Each data item has a specific field, and each field stores a specific type of data. This structured approach facilitates data retrieval, querying, and analysis [9]. Unstructured data refers to data without fixed formats and rules, which usually exists in natural language form and is difficult for machines to directly understand and process. Unstructured data includes but is not limited to text, images, audio, video, and other forms of data. Compared to structured data, unstructured data is more flexible and diverse, and can contain a large amount of details and contextual information, but this also makes processing and analyzing unstructured data more challenging. In order to effectively utilize unstructured data, it is often necessary to use techniques such as natural semantic processing, image processing, audio processing, etc. to transform unstructured data into structured data or extract key information from it [10]. When conducting big data analysis, it is difficult to organize or format unstructured data in a similar way to structured data, and collecting, processing, and analyzing unstructured data is also a major challenge. Moreover, a lot of data is constantly coming in the form of data streams, and it is constantly growing every year, making it difficult to establish prior knowledge to process real-time data in a timely manner. How to efficiently collect, analyze, and process massive structured and unstructured data, and further explore the hidden value behind the data, there

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is still room for further exploration in big data analysis technologies such as artificial intelligence, machine learning, semantic analysis, and image recognition [11].

2.2. Big Data Technology

From the perspective of the lifecycle of big data, the core technologies of big data generally include the following four aspects: ① Big data collection: it is the use of multiple databases to receive data from various sources such as networks and app clients. ② Big data preprocessing, storage, and management: Input a large amount of collected data into a centralized distributed large-scale database, improve data quality through data cleaning, data cleaning, data integration, data conversion, and data protocol processing, and lay the foundation for later analysis work Big data analysis and mining: Utilize distributed databases or computing clusters to summarize and analyze the massive data stored in them, and use various algorithms to extract, refine, and analyze the disorderly data The representation and application of big data: With the help of visual data analysis platforms, correlation analysis of dispersed heterogeneous data is carried out, and complete analysis charts are created. Common visualization technologies include tag clouds, historical flows, spatial information flows, etc. [12].

2.3. Big Data Platform

With the expansion of transaction scale, the continuous updating and development of transaction models, and the diversification of consumer demands, rich production, warehousing, logistics, consumer transactions and other data information are generated every day. Traditional ERP systems have limitations in their ability to efficiently, timely, and accurately analyze and process massive amounts of data. The big data platform centralizes the storage of operational data such as enterprise warehousing, logistics, and consumer information. With the ability of data calculation and analysis, it can effectively integrate and analyze data in the supply chain, extract valuable data from it, and apply it to the decision-making and management process of enterprises. Currently and in the foreseeable future, distributed databases or computing clusters will be the key means for analyzing, classifying, and aggregating massive amounts of data. The six widely used data processing and analysis platforms currently include Hadoop, HPCC, Storm, ApacheDrill, Mapreduce, and Pentaho BI. Among them, Hadoop is the most popular cloud computing platform that can decompose a large amount of data into smaller and easily accessible datasets and send them to multiple servers for analysis, in order to achieve efficient analysis speed. Supply chain big data platforms usually integrate functions such as information integration, production, warehousing, and marketing, including infrastructure layer, data layer, application service layer, and display layer. They usually involve processes such as data collection, storage, calculation, organizational management, analysis and decision-making.

3. Application

The research on big data technology in supply chain management mainly focuses on supply chain management strategic decision-making, supply chain management risk prediction, and improving supply chain management agility. This article will analyze from the above three aspects.

3.1. Strategic Decision-making in Supply Chain Management

The key issue to consider in the application of big data in supply chain strategic decision-making management is supplier selection. Mazzei [13] pointed out that by conducting big data analysis on relevant investment return information of enterprises and information data of potential suppliers, effective support can be provided for organizational strategic decision-making. Using big data technology, analyze and mine historical data of suppliers, such as

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product prices, product quality, and order fulfillment, as the basis for evaluating and selecting suppliers. After selecting qualified suppliers, enterprises can establish long-term, close, and stable strategic partnerships with suppliers, improve their competitive advantages, and reduce enterprise risks; And by controlling various aspects of the procurement business process, such as employee management, information management, etc., procurement costs can be effectively reduced. In terms of strengthening cooperation with suppliers, Zhang et al. [14] pointed out that closely linking buyers and partners, establishing a database of common needs, achieving data exchange and sharing, and using big data technology to help them make procurement decisions are beneficial for cost control and optimization of procurement decisions. In terms of procurement business process control, Liu[15] pointed out that the unreasonable setting of positions and unclear responsibilities in the procurement process, lack of professionalism in market segmentation in the sales process, insufficient information sharing in the inventory process, and high delivery service standards in the logistics process make it difficult to effectively manage the costs of the supply chain. With the help of big data, the responsibilities of procurement positions can be clarified, information sharing can be achieved, and effective control of supply chain costs can be achieved.

In addition, another important application of big data in supply chain management strategic decision-making is the design and development of new products. Big data technology can be used to widely collect customer feedback data, analyze consumer purchasing behavior, and based on this, design and develop products that meet consumer needs and preferences to improve product market adaptability. Big data analysis of consumer purchasing behavior can be achieved through big data classification and clustering calculations. Zhang [16] believes that big data technology can be relied on to label and classify customer needs and consumption preferences, accurately divide customer groups, and then carry out marketing accurately to achieve low investment and high output marketing goals. Jiang [17] believes that location-based services (LBS), big data, and precision marketing can be deeply integrated, providing users with reverse customization services and reverse group buying activity services through four marketing models: product geographic analysis, user behavior analysis, social networks, and personalized recommendations.

3.2. Risk Prediction for Supply Chain Management

Supply chain management involves a wide range of factors, with many potential risks. Enterprises can use the predictive analysis function of big data to combine the operational data generated by the enterprise with social media data, conduct overall analysis of the data, and improve their risk prevention and control capabilities. The risk prediction process of supply chain management is generally divided into three stages: pre prediction stage, in-process control stage, and post management stage.

Firstly, in the pre risk prediction stage, big data technology is used to analyze the semi-structured and structured data generated in the enterprise supply chain management system, which can obtain highly accurate results and effectively improve the enterprise's ability to judge risks [18]. Enterprises can use historical sales data, inventory data, and other data to predict consumer purchasing behavior, effectively grasp market demand, and reduce supply chain management and operational risks. Iftikhar [19] uses social media data from Twitter and Facebook to improve demand forecasting in the supply chain, using sentiment, trend, and word analysis results from social media big data, as well as predictive models for historical sales data to predict product demand.

Secondly, in the risk control stage of the incident, based on data analysis results, help enterprises comprehensively grasp the operation situation and rules of various supply chain management links, and timely identify abnormal situations. Take measures in a timely manner for potential risk links, so as to carry out effective control.

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Thirdly, in the post risk management stage. Big data can provide stable data support for post risk disposal, and through big data analysis technology, identify the root causes of risks, which has a positive effect on making good risk management decisions. Inventory backlog is usually caused by the bullwhip effect in the supply chain. Therefore, big data technology can be combined with virtual inventory theory and intelligent algorithms to guide inventory decision-making plans and reduce the harm caused by the bullwhip effect. Li et al. [20] proposed, based on big data analysis technology and virtual inventory theory, to integrate the idle warehouse resources, inventory and other resources of all node enterprises in the supply chain, as well as warehouse facilities and equipment, and input resource data into a database for unified management. They constructed a system structure that integrates demand forecasting and warehouse path optimization to guide inventory decision-making in enterprises through an inventory sharing mechanism.

3.3. Agility of Supply Chain Management

The external environment of enterprises is in a state of turbulence and change, and due to the increasingly obvious characteristics of personalized and diversified consumer demands, in order for enterprises to survive and develop in a fierce competitive environment, they must improve the agility of enterprise supply chain management through big data technology. In traditional enterprise management, the various components of supply chain management are independent of each other, making it difficult for information to be transmitted smoothly between various links, and enterprises cannot integrate supply chain management, seriously hindering the efficiency and agility of supply chain operation and management. Therefore, if enterprises want to improve the agility of supply chain management, they must solve the problem of information flow. They can integrate various systems through standardized means to improve the timely response speed of the entire system. Enterprises can utilize big data analysis technologies, such as sensor data processing technology, cloud storage systems, visualization technology, etc., as a means for enterprises to obtain, analyze, process, and share supply chain business data. Zhu [21] believes that the smart logistics information platform achieves information collection, transmission, and storage during the logistics process through logistics information service functions. Through the logistics resource transaction function, it can provide convenient online transaction channels for logistics enterprises, suppliers, and customers. It also tracks and monitors the vehicle's driving status, goods situation, and completed orders through technologies such as sensors and GPS.

4. Conclusion

This article analyzes the application of big data technology in supply chain management. Based on the analysis of existing research, it will be summarized from the following three aspects.

(1) Future research should focus on empirical research on the application of major data technologies in supply chain management. Nowadays, there is a lot of research in the academic community on the application of big data in supply chain management, the analysis and decision-making system of big data and supply chain, and platform construction. However, existing research mainly focuses on theoretical descriptions and lacks practical data validation. Big data analysis should be used to mine actual operational data of enterprises, such as through case analysis to achieve an effective combination of theoretical and empirical research, in order to guide enterprise operational decision-making.

(2) In recent years, big data technology has been widely applied in various aspects of the entire supply chain management process. Due to its characteristics of decentralization, anonymity, tamper resistance, and transaction encryption, blockchain has gradually been introduced into the fields of risk control, enterprise financing, and information security management in supply chain management. It is used to solve information delays, traceability, and tracking queries in

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supply chain management Issues such as information tampering and low transaction transparency. Numerous scholars have studied the application of big data technology and blockchain technology in supply chain management, but there are few literature studies that combine big data technology and blockchain technology for supply management. In addition, there are few studies that combine the two technologies to solve problems in logistics processes such as order delays, product damage, errors, and multiple input of data. Big data can collect, analyze, and process data, but it cannot guarantee the authenticity, validity, and security of the data; Blockchain technology based on encryption technology can compensate for the shortcomings of big data; Applying both technologies together to supply chain management will make breakthrough progress in supply chain management.

(3) A complete supply chain collaborative management system has not been formed. Most research on big data technology in supply chain management tends to separate and study various links in the supply chain. Through data analysis and processing, big data model algorithms are applied to various links such as procurement, distribution, and logistics, or coordination and optimization between the two links are carried out. However, the supply chain network is a complete macro framework with a complex structure. Studying the supply chain from a single dimension alone cannot improve the overall supply chain management mechanism and enhance the efficiency of supply chain management. Therefore, how to incorporate all entities and links of the supply chain into the research system and truly achieve supply chain collaborative management research from multiple dimensions has become a challenge that scholars need to overcome in the future. In addition, existing research on supply chain collaborative management has only focused on the cost and expense of big data, which is only a part of the supply chain cost. In order to truly reflect the effect of applying big data to supply chain management, this article believes that the entire supply chain cost generated after applying big data to supply chain management should be analyzed, which is currently a blank field in research.

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