Research on the Application of Big Data Analysis in Supply Chain Risk Management

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Abstract: With the rapid development of big data technology, supply chain management has entered a new era driven by data, and supply chain risk management has also entered a stage of high-quality development. It is necessary to propose solutions for supply chain risk management that better meet market demand, based on the concept of data centered supply chain risk management. Based on the dynamic evolution of big data technology development, a theoretical analysis framework for supply chain risk management is constructed according to the internal logic of supply chain risk management. This framework can explain the development mechanism of supply chain risk management jointly generated by the supply chain risk identification mechanism and risk assessment cycle mechanism participated in by data collection and analysis, and explore the possibility of achieving the high-quality development goal of supply chain risk management from the perspective of practical changes and deduction of supply chain risk management. The purpose of supply chain risk management is to provide security guarantees that meet the expected standards for supply chain participants and to strive to improve the quality of supply chain risk management and enhance supply chain efficiency. To this end, measures such as strengthening risk control based on data analysis quality internal circulation, constructing mechanisms for interaction and communication between risk perception and risk management, and establishing an evaluation system for risk assessment and response should be taken to achieve high-quality development of supply chain risk management, promote supply chain optimization, and truly meet the needs of the market and customers.

1. Introduction

Supply chain risk management is one of the main responsibilities of modern enterprise management and a general term for enterprise operations. It can be divided into basic risk management and non-basic risk management, which are composed of internal risk and external risk. The enterprise also entrusts a professional team to identify and evaluate risks to manage them effectively. Since the rise of big data technology, data analysis has become the key to supply chain risk management, and risk assessment has become an evaluation indicator. Unlike traditional risk management, big data-driven risk management emphasizes the real-time, accuracy, and predictability of data. Therefore, this article proposes the application topic of big data in supply chain risk management, and big data analysis technology provides new solutions for supply chain risk management [1].

Big data technology originates from information processing technology with data as the core, and its data analysis ability contains the potential for risk identification and management, which is also a tool for risk management. In an ideal state, from the perspective of supply chain structure, big data technology pursues early identification of risks and achieves modernization of supply chain risk management through a combination of data collection and analysis. Today, big data technology has embarked on a unique path of combining with supply chain risk management. The comprehensive promotion of big data technology has not only changed the methods of risk identification, reflecting the scientific nature of risk assessment but also changed the strategies for risk response, which has a profound impact on supply chain management. Therefore, we should discuss the application of big

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data in supply chain risk management with a global and forward-looking perspective. As a result, scholars have proposed the proposition of big data application in supply chain risk management. In short, big data technology is the condition and guarantee for achieving innovation in supply chain risk management. In practice, big data technology has made progress in supply chain risk management but with shortcomings. The effective application path of big data in supply chain risk management has not yet been fully identified, and it will continue to make efforts. Therefore, further development of big data technology is needed for supply chain risk management, a technical and strategic issue [2].

Based on the above background analysis, this article proposes a big data-driven supply chain risk management method, aiming to improve the efficiency and accuracy of risk management and solve the problem of risk identification and evaluation through big data analysis theory and risk assessment methods. This method mainly involves collecting, processing, and analyzing risk data, effectively addressing uncertainty risks in the supply chain and has important theoretical and practical significance.

2. Basic Theory and Existing Research Overview of Supply Chain Risk Management Platform

2.1. The Academic Background of Supply Chain Risk Management Business Model Building Services

As the core content of the information technology field, big data technology is of great significance in promoting the migration and application of data analysis concepts in supply chain management and has become a key theory and important means of risk management. This article analyzes data analysis and related risk factors in supply chain management. Through the analysis of big data technology, a big data analysis method for supply chain risk management research is proposed. Then, taking the construction path of the supply chain risk management platform as an example, a possible integration path between big data technology and supply chain risk management is attempted to provide a new approach and research paradigm for risk identification and assessment [3].

2.2. Summary of Research on Service Platform for Supply Chain Risk Management

Supply chain risk management (SRM) generally refers to a discipline that focuses on supply chain, risk identification, risk assessment, and other knowledge related to supply chain risks. It is a general term for management and information science, with distinct applicability and practicality, and presents more complex attributes compared to risk management. In the research process of this field, it is impossible to achieve deeper exploration through quantification and application of traditional risk management models, which to some extent limits the diversity of research methods. With the advent of the big data and cloud computing era, the academic community is increasingly paying attention to research methods for supply chain risk management. In recent years, scholars have begun to pay more attention to the combination of innovation and interdisciplinary approaches, among which the construction and application of big data technology for supply chain risk management is a typical representative. However, based on the complexity of the research objects and issues involved in this field, how to effectively integrate big data technology with supply chain risk management has become a key issue that urgently needs to be solved in the academic community. This study attempts to explore the practical application of the above theories, to provide a theoretical basis and practical reference for promoting the intersection and innovation of internal and external elements in the discipline [4].

2.3. Analysis of Supply Chain Risk Management System

From this perspective, the data involved in supply chain risk management research can be divided into structured data and unstructured data. The former refers to data collected and processed by researchers through databases, surveys, and other means for the first time, while the latter refers to data sourced from research and public reports by others. The data sources of big data reflect the enormous value of supply chain risk management data and add practical difficulties to the

standardization and large-scale utilization of subsequent data standards.

3. Design and Implementation of Big Data System Construction Platform for Supply Chain Risk Management

3.1. Supply Chain Risk Management System Platform Architecture Design

Data architecture construction is the first and most critical step in building big data technology, referred to as the "data modeling" stage. Data architecture is a framework that describes the structure and organization of big data technology. It defines the types of data sources, data storage, and data analysis in big data technology, as well as their relationships, typically represented by an ER diagram. In this process, it is necessary to use a unified form to represent the pattern layer data of the upper-level knowledge system of the data entity, requiring the builder to have a certain level of data abstraction ability and overall control of the entire domain knowledge, to restore the known semantic relationships between existing knowledge to the maximum extent. Taking the well-known supply chain risk management as an example, with risk factors as the narrative core, the narrative includes information such as supplier risk, demand fluctuations, logistics risk, etc. It can be abstracted into a simple data architecture structure, as shown in Figure 1, based on which the corresponding supply chain risk management structure can be fully presented [5].

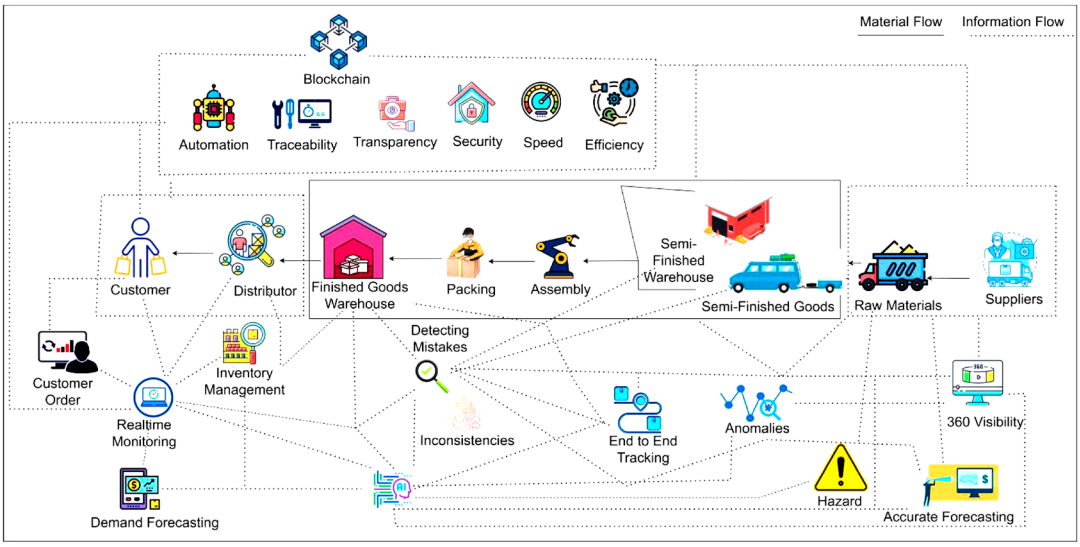

Figure 1: The framework and structure of big data analysis in the supply chain risk management system platform

3.2. Big Data Analysis Strategy for Supply Chain Risk Management Needs

Big data analysis, also known as data mining or data analysis, is an interdisciplinary theory that combines theoretical methods from disciplines such as statistics and machine learning with corresponding methods from information technology. Its basic application logic is to present risk factors, risk assessments, and risk responses in a structured knowledge manner through visual graphics, achieving systematic and structured supply chain risk management knowledge. From the perspective of data application scale, big data analysis can be divided into macro analysis and microanalysis. Among them, macro analysis is a structured knowledge base that contains a wide range of domain information, covering comprehensive knowledge from multiple disciplines and thematic areas. However, the corresponding drawback is that the analysis accuracy is relatively low. Micro-analysis, on the other hand, is a structured knowledge base that focuses on specific fields or topics. Compared to the former, micro-analysis is generally constructed by experts in the field, focusing on deep mining of key information. Therefore, it has higher analysis accuracy and can efficiently assist in deep research and decision support [6].

4. Analysis of the Core Technology of the Business Intelligent Auxiliary System Construction Platform

4.1. Supply Chain Risk Management Entity Generation and Optimization Framework

In supply chain risk management, risk entity identification is the process of automatically extracting structured and meaningful information and knowledge from text. This process is of great significance for the field of supply chain risk management, which mainly focuses on unstructured and semi-structured data. This process aims to extract information from a large amount of text for further storage, organization, or analysis. It usually involves the identification of risk entities, risk relationships, and risk attributes, as well as their relationships. It includes several key steps such as risk entity identification, risk relationship extraction, risk event extraction, and risk attribute extraction. The specific selection is based on the structure of supply chain risk management.

4.2. Supply Chain Risk Management Resource Analysis and Customized Tool Development Technology

In supply chain risk management, the source of supply chain risk management data is first determined. According to the research, data resources in supply chain risk management mostly exist in massive commercial platforms, divided into stock data and real-time data, such as market reports, news releases, social media, etc. Therefore, research is conducted to obtain corresponding data from these platforms and construct an automatic acquisition model based on a big data technology framework. The acquisition framework diagram specifically includes the following modules: the first one is the request scheduling module, which is mainly used to receive link acquisition requests. Secondly, the acquisition module mainly processes all replies and extracts the request links that need to be obtained. Thirdly, the download module serves as the primary function to download the obtained content. Fourthly, the data processing module is mainly responsible for processing the data obtained during acquisition and processing corresponding requests. The main workflow is as follows: the engine obtains the send request sent by the acquisition module and passes it to the scheduler. The scheduling module then accepts the sent request and passes it to the downloader. The download module downloads and acquires the corresponding data from the Internet. The data is filtered and returned to the engine, and finally transferred to the acquisition module. This module needs to extract the required data, transmit it to the data processing module, and after actual processing, make the data into usable form [7].

4.3. Realization of Simple Supply Chain Risk Management Business Functions

When building supply chain risk management, we usually start with two types of relationships: risk factor relationships and risk impact relationships. Risk factor relationships can be directly extracted from raw data, while risk impact relationships require complex calculations on existing data to obtain, which can reveal deeper dynamics between entities. The construction process includes: building a single-layer risk map at the supplier entity level, building a single-layer risk map at the demand entity level, building a single-layer risk map at the logistics entity level, and a multi-level risk map for supply chain risk management. After constructing a multi-level risk map, it is necessary to make correct judgments and quality evaluations on the domain entities that have joined the map to ensure that the constructed risk map has high accuracy. Compared to a single-level risk graph, a multi-level risk graph is structurally more complex, capable of storing more entities and having complex entity relationships. Therefore, a risk assessment model can be used for validation, which is a shared variable risk assessment model with smaller parameter sizes and higher application advantages compared to other models. In the application stage, this model can combine entities and relationships in the risk graph to complete the representation from entity to relationship. In addition, the model can score entities under the influence of the risk assessment function, and select the risk map with the highest score as the accurate risk map. Multiple link predictions are made to improve the accuracy of the risk map, thereby verifying the high accuracy of the constructed risk map.

5. Supply Chain Risk Management System Construction Platform Application Example

Regarding supply chain risk management, relevant policy documents clearly state the need to strengthen the connection of risk management, and risk management should reflect the continuity and advancement of the supply chain. Supply chain managers need to understand the characteristics of each stage of the supply chain and the characteristics of supply chain risk management, to prepare in advance for further deepening of supply chain management. Risk assessment is an important component of the idea and method of forming risk awareness in supply chain management, and it is also the foundation for learning risk management knowledge and forming risk management concepts in the supply chain.

This study was conducted using quantitative analysis, case studies, expert interviews, and other methods. Based on risk assessment as a supply chain risk management literacy, a comparative analysis was conducted on the risk management standards, content, and skills of different industries. It has been found that there is significant similarity and connectivity in risk management standards across different industries, and the content of risk management is highly correlated. Most of the content learned in the initial stage has been learned in the advanced stage, but the content learned in the advanced stage is more complex. The risk management skills in the advanced stage are a continuation and higher requirement of the management concepts proposed in the initial stage. By analyzing the development status of data collection and risk management skills in different industries, we selected enterprises of various sizes as control groups, conducted case studies, and analyzed them to conclude and analyze the existing problems. This article proposes the following strategies for cultivating this literacy among supply chain managers: emphasizing the study of risk management theory, emphasizing the cultivation of risk response capabilities, combining with big data platforms to form intuitive experiences, and emphasizing risk warning guidance. Based on the knowledge learned from relevant policy documents and supply chains in different industries, risk identification, risk assessment, and risk response are selected for teaching design to enable the application of training strategies [8].

Finally, a summary and outlook are made on the development of supply chain risk management skills at the levels of supply chain managers, enterprises, policy management, and strengthening supply chain risk management.

6. Conclusion

By applying big data technology, we can systematically analyze the potential risks and response strategies of each link in supply chain management. This analysis not only enhances risk management but also offers guiding suggestions for supply chain management, assisting managers in accurately understanding the direction of risk management and innovation potential. Therefore, it is important to explore in depth how to effectively integrate big data technology into supply chain risk management research, which not only reveals the potential value of this technology in new fields but also promotes its wider application and development.

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