# Strategies for Empowering Supply Chain Risk Management with Big Data

**Jingwen Zhang[1,a,*]**

[1]College of Economics and Management, Tianjin University of Science and Technology, Tianjin, China

a. jewel1670530887@outlook.com

*corresponding author

*Abstract:* With the rapid development of big data technology, supply chain risk management is facing unprecedented opportunities and challenges. Big data can not only provide accurate risk prediction and real-time monitoring but also reveal potential supply chain risks through data mining and analysis, so as to help enterprises deal with and avoid risks in advance. This study aims to explore the strategy of supply chain risk management under the power of big data and analyze how big data can effectively identify external and internal risks in the supply chain, especially in the uncertain economic environment and global market, how to improve the transparency, adaptability and risk prevention and control level of the supply chain through big data technology. This study also reveals some problems existing in the process of big data enabled supply chain risk management, such as data leakage, lack of technical capacity, information asymmetry, etc., and puts forward corresponding solutions. Finally, the research shows that supply chain risk management enabled by big data can not only enhance supply chain stability but also provide enterprises with effective risk response solutions and promote the intelligent development of supply chain management.

*Keywords:* Big Data, Supply Chain Management, Risk Management, Credit Risk.

## 1. Introduction

McKinsey published a "big data" report (data and industry) in "Big Data Analytics" in 2011, "big data + Industry" has become a new development direction [1]. In recent years, with the rapid development of big data, the members of the supply chain system began to shift from the centralized mode to the distributed mode, which formed a sharp contrast with the previous mode, making the current supply chain collaboration research lack innovation [2]. However, with the in-depth use of big data, enterprises will become more active, more comprehensive, more complete and more scientific risk control procedures and methods when establishing their own supply chain network. For example, the analysis ideas of "Internet + cloud" and "big data + industry" can be deeply excavated and integrated from the key information of product design, production, procurement, logistics and other links [3]. In the system, the use of advanced machine depth neural network can make more accurate and intelligent e-commerce business decisions and improve the efficiency of enterprise management; On this basis, the mobile Internet and big data analysis methods are used to realize the independent adjustment of customers' consumption demand for goods, so as to optimize the upstream

and downstream commodity supply network of the entire industrial chain, so as to enhance the competitiveness of enterprises.

At present, with the globalization of economic development, enterprises face fierce competition, and supply chain relationships are increasingly complex. If an enterprise cannot effectively respond to the various risks it encounters, it will bring huge losses to the enterprise [4]. However, domestic supply chain enterprises have not made substantial progress in operation modes. Therefore, addressing supply chain risks in the big data environment is crucial.

From the perspective of big data enabled supply chain risk management, this paper discusses how to identify and deal with the external and internal risks in the supply chain through big data technology. The research is analyzed from the following aspects: firstly, the impact of external risks (such as social unrest, natural disasters, etc.) and internal risks (such as lack of technical capacity, staff management, data security, etc.) on the supply chain is analyzed; Secondly, according to these risks, the corresponding optimization strategies are proposed, including strengthening technical protection, improving staff ability, enhancing information sharing and collaboration, etc. Finally, the strategy of improving the transparency, adaptability and risk prevention and control level of the supply chain through big data technology is proposed. The significance of this study is that the empowerment of big data technology, provides enterprises with more accurate and flexible risk management tools, helps enterprises deal with supply chain risks more effectively in a complex and volatile market environment, and ensures the stability and reliability of the supply chain. Especially in the globalized and uncertain economic environment, big data can significantly improve the competitiveness and risk resistance of enterprises and play an important role in promoting the intelligent and digital transformation of supply chain management.

## 2. Analysis of Supply Chain Risk Management Issues Driven by Big Data

### 2.1. External Risks

External environmental risks for enterprises mainly stem from social and natural factors and are uncontrollable [5]. Social unrest can cause the collapse of the supply chain structure, resulting in economic losses for upstream and downstream enterprises [6]. Similarly, natural disasters can disrupt production and delay delivery. Although the probability of such external risks is relatively low, their impact is often severe and can have far-reaching consequences for the entire supply chain. For example, a natural disaster in a certain area can not only harm local enterprises but also affect regional social and economic activities [7]. In supply chain management, manufacturing and transportation are particularly vulnerable to natural disasters, highlighting the significant negative impact of external risks. With the globalization of the economy, global events such as the COVID-19 pandemic have further increased the prominence of external risks, bringing challenges to supply chain stability in various aspects such as information disclosure and logistics management.

### 2.2. Internal Risks

#### 2.2.1. Technical Factors

With the continuous emergence of big data, the processing methods of massive data are becoming more and more mature. However, in the network environment, enterprises conduct large-scale network transactions through the network, which makes the problem of information leakage within enterprises inevitable [8]. When the profits of enterprises or enterprises are infringed, it will lead to the stability of the whole supply chain system and even the risk of collapse. Many enterprises outsource big data analysts due to the lack of big data analysts, resulting in the instability of their

technology and profitability, and it is difficult to make full use of the "data dividend" brought by enterprises.

### 2.2.2. Employee Factors

Enterprises should effectively manage various types of data resources, which are usually highly complex and sensitive [9]. With the advent of the era of big data, the operation mode of the supply chain has gradually changed from the extensive operation mode in the past to a more refined and in-depth operation management [10]. In such a big data analysis process, there needs to be a complete process and open to the public. This makes the whole supply chain face greater and broader risks. Even the smallest risk changes require enterprises to detect and make corresponding adjustments as soon as possible. However, if employees lack sensitivity to data and the market, and are unable to quickly detect changes, only responding after problems have arisen, it is highly likely to cause significant losses to themselves and other members of the entire supply chain. Therefore, in this era of big data, higher requirements are put forward for the ability of personnel. They should not only respond in time but also discover problems in the data in advance.

### 2.2.3. Data Security and Privacy Issues

Data security and privacy are one of the most prominent challenges in supply chain risk management supporting big data [11]. As companies and supply chain members share a large amount of data, ensuring the security, reliability and privacy of these data has become a key issue [12]. Parties in the supply chain may include companies of all sizes, which involve sensitive business information and personal data, such as customer orders, payment information and supplier contracts [13]. If the security measures in the data transmission and storage program are not perfect, it is easy to lead to data leakage, abuse or hacker attack. Once the data is disclosed, it may lead to direct economic losses, but it may also damage the company's reputation and even face legal liability. In addition, when companies use big data analysis, they usually rely on third-party service providers or platforms to store and analyze data, which increases data security risks. Therefore, in the big data driven by supply chain management, it is necessary to strengthen data encryption, authority management, privacy protection and other measures to ensure the security of data in the use process. At the same time, the company needs to establish and improve the data management mechanism, strengthen the supervision of data exchange and circulation, and ensure the correctness and compliance of data.

### 2.2.4. Technical Capability and Data Analysis

Although big data has great potential, many companies lack sufficient technical capabilities. Supply chain management includes structured and unstructured data that requires complex algorithms for processing. Small and medium-sized enterprises often lack professional data analysis talent and technical infrastructure, relying on outsourcing services. However, this may not meet market and supply chain changes in the long term. In the face of large-scale data processing, the enterprise's IT system may become a bottleneck, affecting data analysis efficiency and decision-making speed. Insufficient data analysis depth and accuracy can also prevent the identification of potential risks, wasting early warning and control opportunities [14]. Therefore, improving technical capabilities is essential for big data to support supply chain risk management.

### 2.2.5. Information Sharing and Collaboration Issues

Information sharing and coordination are crucial for supply chain risk management. Although big data technology can accelerate information transmission, there are still obstacles in practice. First,

different companies in the supply chain may have competition or conflicts of interest, making them reluctant to share information such as price, inventory, and production plans. Additionally, different data formats and technology platforms among companies make data communication and integration difficult. Even with information sharing, the decision-making process and cooperation mechanism may not be efficient enough, resulting in slow responses to emergencies. For example, a supplier's production delay can lead to downstream delivery delays and supply chain failure [15]. Therefore, establishing a unified standard and information platform and improving the cooperation mechanism are necessary to enhance supply chain risk management efficiency.

## 3. Big Data Empowers Optimization Strategies for Supply Chain Risk Management

### 3.1. External Factors

First, enterprises should strengthen the construction of dynamic monitoring and early warning systems for the external environment [16]. For example, through cooperation with government departments, scientific research institutions and industry associations, real-time access to information related to social unrest, natural disasters, etc., and combined with data analysis technology, timely predict potential risks [17]. On this basis, the emergency plan is formulated to clarify the division of responsibilities and specific operation procedures of each department, so as to ensure that the enterprise can respond quickly and minimize the loss in case of emergencies.

Secondly, improving the diversity and flexibility of the supply chain is the key to dealing with external risks. Enterprises can avoid the overall collapse caused by the failure of a single supply chain node by expanding diversified supply channels and sales networks. For example, multiple alternative suppliers and manufacturing bases can be deployed globally, so that resources can be quickly switched in case of risk in a certain region. In addition, regional production and inventory strategies can also be adopted to set up emergency inventory in areas close to major markets to deal with logistics disruption.

In the context of force majeure such as natural disasters, enterprises can cooperate with insurance institutions to purchase risk insurance to reduce economic losses. At the same time, through technology investment and upgrading, such as building a digital supply chain platform, can realize real-time visual management of the entire chain, facilitating problem location and strategy adjustment during emergencies.

In addition, it is also crucial to strengthen the collaboration between enterprises and upstream and downstream partners of the supply chain. Through the establishment of strategic partnerships and common risk management mechanisms, the transparency and efficiency of information sharing will be enhanced, so that supply chain members can cope with risks cooperatively and form the anti-risk ability of "sharing and win-win".

Finally, enterprises should enhance their flexible management capabilities, such as introducing agile management methods and reserving a certain elastic space in resource allocation, personnel scheduling and business planning to adapt to the rapid changes in the external environment. The experience of COVID-19 shows that enterprises need to continuously optimize logistics management and information disclosure to meet the uncertain challenges in the future while strengthening the informatization and digitalization capabilities.

### 3.2. Internal Factors

#### 3.2.1. Technical Factors

First, strengthen network security protection, adopt advanced encryption technology, set up multi-layer firewalls, and regularly update the security system to minimize the risk of information leakage

[18]. At the same time, enterprises need to gradually establish internal big data analysis teams to reduce the dependence on outsourcing services, so as to enhance data control and stabilize technology and profitability. In addition, through cooperation with technology service providers or research institutions, enterprises can obtain cutting-edge data processing technology and management experience to further optimize the technical efficiency of the supply chain. On this basis, establish a perfect technology emergency mechanism to ensure rapid response and control losses in the event of data leakage and other emergencies, and comprehensively improve the ability to cope with technical risks.

### 3.2.2. Employee Factors

For the problem that employees are not sensitive to data and market changes, enterprises should focus on improving personnel quality and risk response ability. Regularly organizing big data training can help employees master data analysis tools and understand their business value, enhancing data interpretation and prediction capabilities. At the same time, strengthening risk awareness training through simulations can enable employees to identify potential problems early and take countermeasures quickly. Optimizing the organizational structure by introducing professional data management personnel and setting up a special risk monitoring department can centralize the management of complex data resources. In addition, establishing an incentive and feedback mechanism can encourage employees to innovate and respond promptly to market and supply chain changes, further improving enterprise operation toughness and adaptability.

### 3.2.3. Data Security and Privacy Protection

To solve data security and privacy problems, enterprises can take a series of technical and management measures. Widely using encrypted data for transmission and storage can prevent sensitive data leakage. Establishing a strict authority management system can ensure that only authorized employees can access and process data. Using blockchain technology can improve data transparency and prevent tampering. In case of data leakage, enterprises should formulate emergency plans and implement detection and early monitoring response mechanisms to prevent loss expansion. At the same time, strengthening data exchange agreements with partners can ensure data compliance with laws and regulations and privacy protection requirements, enabling enterprises to better handle security challenges and ensure supply chain management.

### 3.2.4. Technical Capability and Data Analysis

To overcome the bottleneck of technical capability and data analysis, enterprises need to increase investment and improve capabilities. First, increasing investment in data analysis and artificial intelligence research and development through internal training or external cooperation and involving professionals can enhance data analysis ability [19]. For small and medium-sized enterprises, using cloud computing as a big data platform can lower the technical threshold. However, it is not necessary to ensure the reliability of the platform to avoid excessive dependence. Secondly, strengthening data infrastructure construction, especially for large-scale data processing, improving the system architecture can improve processing efficiency and analysis accuracy. Applying advanced algorithms and artificial intelligence technology can extract valuable information from data for early warning and monitoring of potential risks. Finally, establishing a quality management system can ensure data accuracy and consistency, avoiding the impact of data quality on analysis results and decision-making efficiency.

### 3.2.5. Information Sharing and Collaboration Mechanism

In order to solve the problem of information exchange and coordination in big data supply chain risk management, enterprises to create an effective information exchange platform and promote the unity and consistency of all parties in the supply chain in data exchange [20]. First, the company should strengthen the construction of an information platform among supply chain partners and formulating common standards and interface protocols can ensure data sharing and smooth circulation. At the same time, strengthening trust building with upstream and downstream enterprises can reduce hidden barriers caused by competition or information asymmetry. Encouraging the sharing of key information such as inventory and transportation status while ensuring privacy can improve supply chain transparency. Secondly, the company should improve the decision-making process of the supply chain and strengthen the rapid response and cooperation of all parties in the face of risks, such as establishing a real-time monitoring and early warning mechanism, can reduce the risk transmission possibility. Through these measures, enterprises can enhance information exchange efficiency and supply chain risk management capabilities.

## 4. Conclusion

This study discusses the strategy of supply chain risk management under big data empowerment and analyzes the role of big data technology in improving the transparency, forecasting ability and risk response of the supply chain. By analyzing the cases of the Tencent micro enterprise chain and Mengniu supply chain, this paper shows the practical application effect of big data in supply chain financing, credit risk control and solvency analysis, and emphasizes that big data can effectively identify the external and internal risks in the supply chain. Research shows that big data technology not only helps enterprises enhance their risk prediction and emergency response capabilities but also improves the stability and reliability of the supply chain. However, problems such as data security, technical capabilities and information sharing still exist, which poses a challenge to big data enabled supply chain risk management. In the future, enterprises should strengthen data security protection, improve technical capabilities and promote cross enterprise information collaboration to achieve more efficient and intelligent supply chain risk management. In the context of the accelerated development of globalization and digitalization, big data technology will continue to play an important role in supply chain management and promote enterprises to deal with the complex and volatile market environment.

## References

[1] Manyika, J. (2011). Big data: The next frontier for innovation, competition, and productivity. McKinsey Global Institute, 1.
[2] Tang, C. (2024). Supply Chain Financing Strategies of Enterprises under the Big Data Concept. Modern Business, (11), 131-134.
[3] Zhou, A., & Lu, H. (2024). Research on Risk Management of Supply Chain Financing for Small and Medium Enterprises in Hainan in the Era of Big Data. Modern Marketing (Monthly Issue), (05), 112-114.
[4] Song, X., Liu, F., Shen, Z., & Li, M. (2024). Construction of an Integrated Model for Supply Chain Risk Management and Competitive Intelligence under Big Data—A Case Study of Huawei. Journal of Intelligence, (06), 185-192+176.
[5] Wang, Z. (2023). Analysis of Supply Chain Financial Risk Management Strategies under the Background of Big Data. Huazhang, (07), 99-101.
[6] Zhao, J. (2023). Research on Supply Chain Financial Risk Management Based on Big Data—Review of "Research on Credit Risk Evaluation Methods Based on Supply Chain Finance under Big Data". China Science and Technology Papers, (04), 482.
[7] Zhang, S. (2023). Innovative Applications of Financial Technology in Supply Chain Financial Risk Management. Modernization of Mall, (02), 95-97.

[8]  Yu, H., & Yang, F. (2022). Research on Risk Management of JD's Supply Chain Finance under Big Data Background. China Business Review, (13), 70-72.

[9]  Liu, X. (2022). Analysis of the Causes and Countermeasures of Supply Chain Management Risks from the Perspective of Big Data. China Collective Economy, (16), 10-13.

[10] Wang, W. (2022). Research on Supply Chain Financial Risk Management under Big Data Background (Master's Thesis, Jiangxi University of Finance and Economics). Master's Thesis.

[11] Li, X. (2022). Application of Big Data in Credit Risk Management of Supply Chain Finance (Master's Thesis, Guangzhou University). Master's Thesis.

[12] Liu, J. (2021). Research on Credit Risk of Small and Medium Enterprises in Supply Chain Finance under Big Data Technology (Master's Thesis, Guizhou University of Finance and Economics). Master's Thesis.

[13] Xu, Y. (2020). Research on Risk Avoidance in Automotive Sales Supply Chain Finance Based on Big Data (Master's Thesis, Beijing University of Civil Engineering and Architecture). Master's Thesis.

[14] Li, G. (2020). Research on Supply Chain Risk Identification and Monitoring Based on Big Data Analysis. Supply Chain Management, (07), 42-52.

[15] Ouyang Zhaoyong & Liu Guanlin. (2024). Research on Innovation Strategy of Supply Chain Management of Agricultural Enterprises Under the Background of Big Data. Proceedings of Business and Economic Studies (4), 275-282.

[16] Zahra Esmaeeli, Naser Mollaverdi & Soroush Safarzadeh. (2024). A game theoretic approach for green supply chain management in a big data environment considering cost-sharing models. Expert Systems With Applications 124989-124989.

[17] Jehoshaphat Jaiye Dukiya. (2024). An Overview of the Application of Big Data in Supply Chain Management and Adaptation in Nigeria. Journal of Computer and Communications (08), 37-51.

[18] Tipu Syed Awais Ahmad & Fantazy Kamel. (2024). Linking big data analytics capability and sustainable supply chain performance: mediating role of innovativeness, proactiveness and risk taking. International Journal of Productivity and Performance Management (5), 1587-1608.

[19] Tambuskar Dhanraj P., Jain Prashant & Narwane Vaibhav S. (2024). An exploration into the factors influencing the implementation of big data analytics in sustainable supply chain management. Kybernetes (5), 1710-1739.

[20] Xiaochen Zhou, Jijiao Jiang, Cong Zhou, Xiang Li & Ming Yin. (2024). Circular supply chain management: Antecedent effect of social capital and big data analysis capability and their impact on sustainable performance. Sustainable Development (5), 5311-5330.