# Recent Research Advances and Challenges in Supply Chain Resilience Management

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**Abstract.** This paper explores recent research advances and challenges in supply chain resilience management, aiming to provide a comprehensive overview of current supply chain resilience theory and practice. Firstly, this paper defines the core concepts of supply chain resilience management and describes related theories, including supply chain risk management theory, dynamic capability theory and complexity theory. Next, the paper discusses in detail the latest research progress in supply chain resilience management, analysing it from strategic perspectives, technical support and digital development, enterprise case studies, and indicator systems. Supply chain vulnerability, complexity and uncertainty brought about by globalisation, challenges brought about by technological development and problems in business management are explored. In response to these challenges, the paper proposes future research directions, including dynamic capability enhancement, application of artificial intelligence and machine learning, integrated risk management, cross-industry comparative studies, and sustainable development. Ultimately, the paper summarises the key findings and proposes strategies to address them, such as risk assessment, information transparency, supplier optimisation, inventory management and technological innovation. Through these measures, companies can improve the resilience of their supply chains, ensure that they maintain stable operations in complex and uncertain environments, and achieve long-term competitive advantage.

**Keywords:** Supply chain resilience management; globalisation challenges; technology support; risk management.

## 1. Introduction

With the rapid development of the global economy, the complexity and uncertainty of supply chains are increasing, and various types of risk factors, such as natural disasters, economic fluctuations and political conflicts, pose great challenges to the stability of supply chains. In order to effectively cope with these risks, enterprises need to enhance the resilience of their supply chains on the basis of traditional supply chain management, so that they can quickly respond to unexpected events and resume operations. Supply chain resilience management, as a key strategy to cope with supply chain vulnerability, has received extensive attention and in-depth research in recent years. In this paper, we will discuss the latest research progress in the field of supply chain resilience management from the conceptual and theoretical basis of supply chain resilience management, and analyse the challenges and future development direction, aiming to provide enterprises with theoretical support and practical guidance for enhancing supply chain resilience.

## 2. Concepts and Theoretical Foundations of Supply Chain Resilience Management

### 2.1. Definition of supply chain resilience management

Supply chain resilience management refers to the ability of a supply chain to react quickly, adjust effectively and resume normal operations in the face of unexpected events or external shocks. This type of management emphasises the flexibility, adaptability and resilience of the supply chain and aims to improve the efficiency of the supply chain in responding to various risks and reduce the impact of disruptions. Unlike traditional supply chain management, resilience management pays more attention to the overall resilience of the supply chain, and achieves rapid response and recovery of

the supply chain by means of optimising processes, establishing contingency plans and improving the level of information sharing. In addition, supply chain resilience management also includes forward-looking risk prediction and management, and enterprises should not only be able to cope with known risks, but also have the ability to deal with potential unknown risks. This multi-level and multi-dimensional management strategy has become particularly important in the current highly globalised and complex supply chain environment, and is a key factor in ensuring supply chain stability and continuity.

### 2.2. Relevant theories

The theoretical foundations of supply chain resilience management mainly cover supply chain risk management theory, dynamic capability theory and complexity theory. Supply chain risk management theory emphasises that enterprises should reduce the likelihood of supply chain disruptions and enhance their emergency response capabilities by identifying, assessing and responding to potential risk factors. Dynamic capability theory, on the other hand, suggests that enterprises should have the ability to continuously update their resources and capabilities in a rapidly changing environment in order to enhance their competitive advantage[1]. For supply chain resilience management, dynamic capability is reflected in the ability of enterprises to flexibly respond and adjust to external shocks. Complexity theory stresses that supply chain as a complex adaptive system, its components are interdependent and affected by the external environment, so managers must recognise the uncertainty and complexity in the supply chain and adopt distributed decision-making and flexible management strategies. By combining these theories, companies can better understand and manage the resilience of their supply chains to ensure adequate adaptability and resilience in the face of risk.

## 3. Recent Research Progress in Supply Chain Resilience Management

### 3.1. Strategic perspectives on supply chain resilience management

From a strategic perspective, supply chain resilience management needs to be at the centre of an enterprise's overall operational strategy. Enterprises should not only improve the resilience of their supply chains through short-term risk response measures, but also plan the resilience design of their supply chains from a long-term perspective. In a globalised supply chain, enterprises face more external uncertainties, such as natural disasters, trade frictions and policy changes, and therefore need to strategically build a diversified supply chain network to mitigate single-source or regional risks through supplier diversification, geographic distribution and regionalised production. At the same time, companies also need to implement proactive risk prevention strategies in their supply chain management, including by regularly assessing supply chain risks, establishing contingency plans and optimising inventory management to ensure that they can react quickly and adjust their operational strategies in the event of unforeseen circumstances[2]. The resilience strategy should also incorporate digital tools and technologies to enhance the visibility and transparency of the supply chain, thereby enabling rapid information sharing and collaborative decision-making, and further enhancing the agility and resilience of the supply chain. By incorporating supply chain resilience management into long-term corporate strategies, companies can maintain a competitive advantage in volatile environments and achieve sustained and robust growth.

### 3.2. Technical support and digital development

Technological support and digital development are important enablers to enhance supply chain resilience management. In the digital era, advanced technologies such as big data, Internet of Things (IoT), Artificial Intelligence (AI) and blockchain are gradually being integrated into supply chain management, enhancing the transparency and controllability of the supply chain. Big data and AI technologies can help companies make more accurate demand forecasts and risk assessments, and make timely adjustments to their supply chain strategies by analysing and forecasting historical data. IoT, on the other hand, provides instant feedback on supply chain status through real-time monitoring

of the operation of each link in the supply chain, thus improving response speed and decision-making efficiency. The introduction of blockchain technology further enhances the information security and transparency of the supply chain, ensures that data transmission and transaction records in the supply chain are traceable and tamper-proof, and reduces the risk of information asymmetry. In addition, the application of cloud computing platforms promotes data sharing and collaboration in the supply chain, enabling enterprises to communicate and coordinate more effectively with upstream and downstream partners in the supply chain. Through the combination of these technologies, enterprises can realise the digital transformation of the supply chain, improve its resilience and adaptability, and ensure that the supply chain can operate efficiently and recover quickly in the face of a complex and changing environment.



**Figure 1.** Technical support and digital development

### 3.3. Enterprise case studies

In the practical application of supply chain resilience management, many enterprises have already demonstrated success through innovative practices. For example, Amazon, with its globally distributed warehousing and logistics network, is able to quickly adjust its distribution programme in the face of unexpected events to ensure uninterrupted service[3]. By deploying highly automated warehousing systems, utilising big data for demand forecasting and implementing diversified supplier management strategies, Amazon has greatly enhanced the flexibility and resilience of its supply chain. Another success story is Apple, whose supply chain is highly global yet highly resilient. By establishing long-term relationships with multiple suppliers and maintaining strategic inventories of key components, Apple ensures that production can be adjusted quickly in the event of supply disruptions. Apple also monitors its supply chain in real time through a digital platform to identify and respond to potential risks. In addition, Toyota Motor Corporation has built an efficient supply chain system through its "Lean Manufacturing" and "Just-In-Time" models, which enables it to quickly resume production in the event of an emergency and reduce waste in inventory management. The successful practices of these enterprises show that supply chain resilience management, which combines technological innovation and strategic planning, can effectively improve enterprises' risk resistance and market competitiveness.

### 3.4. Indicator system for supply chain resilience management

A system of metrics for supply chain resilience management is used to assess the performance and resilience of supply chains in the face of risk and uncertainty. Key indicators include response time, recovery time, inventory turnover and supplier reliability. Response time refers to the time it takes from the occurrence of a risk event to the time the supply chain takes action, with shorter response times indicating greater resilience. Recovery time measures the time from when a disruption occurs to when the supply chain resumes normal operations, with shorter recovery times indicating greater

resilience. Inventory turnover reflects the efficiency of inventory management, with a high turnover rate implying more effective inventory control and greater responsiveness. Supplier reliability assesses the stability and delivery capability of suppliers, including on-time delivery and quality pass rate, which directly affect the stability of the supply chain. In addition, supply chain flexibility and adaptability can be assessed by modelling performance under different risk scenarios, including diversified supply sources and resilience of production capacity. Used in combination, these indicators can provide a comprehensive assessment of the level of supply chain resilience and provide a basis for further optimisation of management strategies.

## 4. Challenges of Supply Chain Resilience Management

### 4.1. Globalisation and supply chain vulnerability

The vulnerability of supply chains has increased significantly in the context of globalisation. With the internationalisation of supply chains and transnational operations, enterprises are facing more complex risks while enjoying optimal allocation of global resources and cost advantages. Globalised supply chains often involve multiple countries and regions, increasing dependence on different laws and regulations, political environments and economic conditions[4]. This complexity makes supply chains more vulnerable to a variety of external shocks, such as trade wars, tariff changes, geopolitical tensions and natural disasters. For example, the 2020 New Crown epidemic exposed the vulnerability of global supply chains, with many firms experiencing production stoppages and logistical bottlenecks due to supply chain disruptions. In addition, globalisation has led to a transmission effect of supply chain disruptions, where risks in one location can quickly spread to the entire supply chain network, affecting the overall stability of the supply chain. To address these challenges, enterprises need to consider supply chain resilience design in their globalisation strategies, including diversifying suppliers and production bases, building contingency reserves and enhancing supply chain transparency, in order to mitigate the potential risks associated with globalisation.



**Figure 2.** Globalisation and supply chain vulnerability

### 4.2. Complexity and Uncertainty

The complexity and uncertainty of supply chains are major factors that challenge their resilience. Complexity arises from the supply chain's multi-tiered structure, multiple suppliers and widely distributed production facilities, where changes in each link can affect the stability of the entire supply chain. This complexity increases the difficulty of management and coordination, making it more difficult for the supply chain to react quickly and effectively in the face of unexpected events. At the same time, uncertainties, such as fluctuations in market demand, rising raw material prices, and policy changes, further exacerbate the vulnerability of the supply chain. As the supply chain involves multiple links and is interdependent, small-scale disturbances can quickly amplify and lead to larger-scale supply chain disruptions. Companies need to respond to these uncertainties by improving supply chain visibility and implementing real-time monitoring and data analysis. At the same time,

establishing flexible supply chain strategies, such as modular design and redundant supply chain networks, can help organisations better adapt to change and reduce the impact of potential risks. By coping with complexity and uncertainty, organisations can increase the resilience of their supply chains and ensure stable operations under various environmental conditions.

### 4.3. Challenges posed by technological developments

While technological developments have brought many opportunities for supply chain management, they are also accompanied by a series of challenges. With the widespread adoption of digital technologies, data security and privacy protection have become major issues. Enterprises need to handle large amounts of sensitive information when adopting big data, IoT and blockchain technologies, and leakage or malicious attacks on this data could lead to serious supply chain disruptions. At the same time, the rapid evolution of technology requires organisations to continuously update their systems and platforms, bringing high investment costs and pressure to adapt to technology. In addition, integration and compatibility issues of technology systems are among the challenges[5]. Poor compatibility between different technology platforms and systems may lead to information silos, affecting the overall efficiency and coordination of the supply chain. The complexity of technology also increases the difficulty of operation, and employees need continuous training to adapt to the application of new technologies. While promoting technology development, enterprises need to develop comprehensive technology management and risk prevention and control measures to ensure the safety and reliability of the technology and the smooth operation of the system, so as to give full play to the role of technology in supporting supply chain resilience.

### 4.4. Challenges of business management

Business management faces many challenges in improving supply chain resilience. Collaboration and communication problems within an organisation often affect the overall responsiveness of the supply chain. The supply chain involves multiple departments and levels, making information transfer and coordination difficult, and poor management can lead to lagging decision-making and poor response. Management challenges faced by enterprises also include resource allocation and optimisation. How to effectively allocate and mobilise resources in the face of risks to ensure the continuity of production and supply is an important part of enhancing supply chain resilience. Enterprises also need to overcome cultural and structural barriers when implementing resilience management strategies. Traditional organisational culture may hinder change and innovation, while complex organisational structures may reduce flexibility in decision-making. Further, the lack of comprehensive risk assessment and contingency planning is also an important issue in business management. Many enterprises often fail to fully consider all potential risks when formulating their response plans, resulting in inadequate responses in practice. In order to meet these challenges, enterprises need to establish a sound management system, strengthen cross-departmental cooperation, optimise resource allocation, and formulate scientific risk management and contingency plans to enhance the resilience and stability of the overall supply chain.

## 5. Future Research Directions and Countermeasures of Supply Chain Resilience Management

### 5.1. Research Directions

In future research on supply chain resilience management, several key directions deserve attention. Digging deeper into the dynamic capability of supply chain resilience, i.e. how to continuously adjust and optimise supply chain strategies in an ever-changing environment, will be an important direction. This includes research into how to improve supply chain adaptability and responsiveness through technological innovation and organisational change. The application of artificial intelligence and machine learning technologies in supply chain resilience management is promising, and future

research could focus on how these technologies can improve forecast accuracy and decision-making efficiency to help companies better cope with uncertainty. Another research direction is the comprehensive assessment of supply chain risk management, including the analysis of the economic impact of supply chain disruptions and the comprehensive response strategies for different risk types. In addition, cross-industry and cross-regional comparative studies on supply chain resilience are also of great significance to reveal best practices and lessons learnt on resilience management in different industries and regions. Finally, as sustainable development has become a hotspot of global concern, research on how to integrate environmental and social factors into supply chain resilience management systems to optimise green supply chains and social responsibility is an important research direction for the future. These researches will help enterprises to establish a more robust and flexible supply chain system in the complex and changing global environment.

### 5.2. Coping strategies

Addressing the challenges of supply chain resilience management requires a combination of strategies. Enterprises should establish a sound risk identification and assessment mechanism, identify potential supply chain vulnerabilities through regular risk assessments and simulation exercises, and develop targeted contingency plans. Strengthening supply chain transparency and information sharing is the key to improving resilience. Enterprises can implement real-time monitoring systems and information management platforms to ensure a smooth flow of data in all links of the supply chain, and obtain and respond to abnormal situations in the supply chain in a timely manner. In addition, enterprises should also focus on supplier management and partnership optimisation to reduce reliance on a single source of supply through diversified supplier selection and strategic cooperation, thereby reducing the risk of supply chain disruption. Enhancing the flexibility of inventory management is also one of the coping strategies to ensure that normal operations can be maintained in case of supply chain disruptions through timely inventory replenishment and safety stock settings. Finally, promoting technological innovation and digital transformation is also a key strategy. Through the introduction of advanced technological tools, such as artificial intelligence, blockchain and big data analytics, the level of supply chain intelligence and automation capabilities can be enhanced, thereby increasing the adaptability and resilience of the supply chain. These integrated strategies will help enterprises maintain supply chain stability and flexibility in the face of various challenges.

## 6. Conclusion

In summarising the research progress and challenges of supply chain resilience management, several important conclusions can be drawn: first supply chain resilience management has become particularly important in the current context of globalisation and rapid technological development. Enterprises need to incorporate resilience management into their core operation strategies at the strategic level, and improve the overall supply chain resilience by optimising supply chain design, enhancing technical support and improving information transparency. Second, complexity and uncertainty pose a major challenge to supply chain stability, requiring enterprises to consider and respond comprehensively in risk management, supplier relations and technology application. Third, technological development and digital transformation provide strong support for supply chain resilience, but also bring new issues such as data security, system compatibility and operational complexity. Enterprises should actively explore how to use advanced technologies to enhance supply chain responsiveness and adaptability, while addressing the challenges in technology application. Future research should focus on how to optimise supply chain resilience in different environments and industry contexts, incorporating cross-industry best practices to drive innovation and development in supply chain management. Through these efforts, enterprises can maintain their competitive advantages and achieve sustainable development in a complex and changing market environment.

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