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Global Supply Chain Risk Identification and Response Strategies

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Abstract. The COVID-19 pandemic, geopolitical conflicts and extreme climate events have disrupted global supply chains, exposing the fragility of the traditional efficiency-first model. Taking political, economic risks and natural risks as research objects, this paper reviews risk identification theories and deconstructs two cases—Apple's friendshoring and Toyota's response to the Great East Japan Earthquake—to extract behavioral logic and decision-making mechanisms against different risks. The study finds that firms need to shift from passive emergency response to active defense, establishing a four-stage framework "Prediction–Protection–Buffering Recovery", with comprehensive implementation of strategies covering four dimensions: multi-sourcing, dynamic buffer inventory, digital monitoring and optimization of supply chain network structure. This paper points out that current research still lacks sufficient discussion on the interactive mechanism between enterprises' micro-level dynamic capabilities and risk management. Future research can further explore how emerging technologies reshape the practical paradigm of supply chain risk management. This study offers theoretical insights and practical implications for risk management decision-making in multinational corporations amid intensifying uncertainties in global supply chains.

Keywords: Global Supply Chain, Risk Identification, Response Strategy, Supply Chain Resilience, Case Study

1. Introduction

Since the 1990s, advances in communication and lower transport costs have deeply integrated global supply chains, with intermediate goods trade rising from 9% to 29% of GDP. Yet this specialization harbors structural vulnerabilities. Trade frictions, COVID-19, the Russia-Ukraine conflict and other shocks have pushed supply chains from integration toward diversification and regionalization, making security the core consideration for multinationals over efficiency.

Academic research on supply chain risk management has accelerated accordingly. Emrouznejad et al. [1] systematically reviewed research progress on supply chain risk identification, assessment and mitigation strategies through bibliometric and content analysis, identifying core strategies including supplier diversification and risk pooling. Abdallah et al. [2] mapped the conceptual framework of resilient supply chains via a systematic literature review, offering an analytical framework for understanding the resilience performance of supply chains at multiple decision-

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making levels. In terms of organizational capabilities, the Organization for Economic Co-operation and Development (OECD) [3] highlights that the triple capabilities of "Agility–Adaptability–Alignment" constitute reliable sources of supply chain resilience. Puchongkawarin et al. [4] further investigated risk management strategies amid global supply chain disruptions, providing theoretical support for interpreting corporate decision-making logic under superimposed multiple risks. However, most existing studies take a single risk category as the entry point, with limited exploration of how enterprises conduct comprehensive risk management decisions under overlapping risk scenarios.

Against this backdrop, this paper focuses on the following research questions: (1) How to classify and identify political, economic and natural risks facing global supply chains? (2) What similarities and differences exist in the strategies adopted by enterprises in typical cases to cope with different types of risks? (3) How to construct a comprehensive response framework addressing multiple risks? Adopting literature review and case study methods, this paper aims to fill gaps in integrated risk analysis and systematic strategy formulation in existing research, and offer references for the risk management practices of multinational corporations.

2. Theoretical foundation and identification framework of global supply chain risks

2.1. Concept definition and classification system of supply chain risks

This section introduces risk classifications. Siriwan [5] groups risks into operational, social, natural, economic, and political/legal. The PMESII-PE framework covers politics, military, economy, society, information, infrastructure, and physical environment. By comparing various classification systems, this subsection clarifies the rationale and analytical boundaries for adopting the three major risk categories (political risk, economic risk, and natural risk) in this paper.

2.2. Primary methods and tools for supply chain risk identification

This subsection reviews methods such as literature analysis, expert interviews, FMEA, and complex network analysis, with emphasis on López et al. [6] who analyzed 80 papers to identify six geopolitically induced disruptions and management decisions, showing the value of systematic literature review.

2.3. Evolution of supply chain resilience theory

Supply chain resilience has emerged as a core concept in risk management research in recent years. This subsection reviews the evolutionary trajectory of resilience theory from engineering resilience (returning to the original state) to social-ecological resilience (transitioning to a more desirable state). The definition proposed by Abdallah et al. emphasizes the supply chain's capacity to "restore initial conditions or shift to a superior state", reflecting the expanded connotation of resilience. In terms of resilience evaluation, Liu et al. [7] systematically reviewed indicator systems and measurement methods for supply chain resilience assessment, providing a reference framework for multi-dimensional resilience measurement. On this basis, dynamic capability theory is introduced as an analytical lens for interpreting supply chain resilience, laying a theoretical foundation for subsequent case analysis.

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3. Major risk categories facing global supply chains

3.1. Political risks

This subsection outlines the multi-dimensional impacts of geopolitical conflicts on supply chains. The Russia-Ukraine conflict triggered sharp surges in global prices of bulk commodities, including crude oil, natural gas, steel, fertilizers and grain, caused energy crises across European countries, and disrupted international air logistics. The Israel-Palestine conflict has created severe hidden dangers for transportation safety in the Red Sea and adjacent waters [8]. The systematic review by López et al. further reveals six types of geopolitically driven supply chain disruptions and their differentiated impacts on financial management, inter-firm collaboration, resilience construction and supply chain restructuring.

3.2. Economic risks

This subsection analyzes the impacts of economic factors such as tariff barriers, exchange rate fluctuations and demand uncertainty on supply chains. Since 2018, US tariff policies have continuously accelerated the "de-Chinaization" of supply chains. China's share of US imports declined by 8.2% from 2017 to 2024, with Mexico surpassing China as the largest source of US imports [9]. From the perspective of production chain length, Ni et al. [10] measured and conducted international comparisons of China's industrial chain risk exposure, revealing varying risk exposure levels across different industrial chain segments. As trade frictions intensify, manufacturers worldwide have increasingly recognized that the traditional efficiency-prioritized supply chain model cannot withstand shocks from complex and volatile risks. Meanwhile, global supply chains are accelerating their restructuring into three regional manufacturing systems: North America, Europe and Asia.

3.3. Natural risks

This subsection discusses disruptions to supply chains caused by natural disasters and public health emergencies. The COVID-19 pandemic and recurrent extreme weather events have repeatedly disturbed global logistics networks, hitting electronics manufacturing—an industry highly reliant on precision components and cross-border assembly—the hardest. Interruptions in the supply of key materials such as semiconductors have exacerbated the bullwhip effect. The 2011 Great East Japan Earthquake triggered large-scale paralysis of automotive semiconductor supply chains, forming a typical case of systematic supply disruption stemming from natural disasters [11]. In addition, typhoons, floods and other extreme weather events pose persistent threats to supply chain infrastructure in key manufacturing regions across Southeast Asia.

4. Analysis of typical cases

4.1. Case of political risk response: Apple's friendshoring strategy

Taking Apple Inc. as a typical case, this subsection analyzes the drivers and paths of supply chain restructuring amid geopolitical pressures [12]. Against the backdrop of China-US trade frictions, Apple promoted friendshoring and required its Chinese supplier GoerTek to relocate production lines from China to Vietnam. While following Apple's strategic arrangement, GoerTek suffered substantial efficiency losses and thus took initiative to diversify its customer portfolio to hedge risks

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arising from over-reliance on a single client. Apple later further launched a USD 600 billion "Made in America" initiative to push relevant manufacturing segments back to the United States. This case analyzes how enterprises balance efficiency and security under geopolitical pressures, as well as the complex coping strategies adopted by suppliers facing multiple requirements.

4.2. Case of natural risk response: Toyota's supply chain resilience development

Taking Toyota Motor Corporation as a typical case, this subsection analyzes how enterprises learn from severe natural disasters and systematically build supply chain resilience [13]. The 2011 Great East Japan Earthquake suspended production at Renesas Electronics, Toyota's core supplier, cutting off supplies of automotive microcontrollers and posing a severe test to Toyota's coordination system. Toyota subsequently reflected deeply on the vulnerabilities of the Just-in-Time (JIT) production model under extreme shocks and implemented five innovative global strategies, including expanding the network of chip suppliers, increasing safety stock for critical components, redesigning automotive electronic systems to reduce reliance on scarce semiconductors, deepening partnership collaboration with suppliers, and accelerating the application of digital tools for supply chain visualization and demand forecasting [13]. These lessons enabled Toyota to demonstrate far stronger resilience and recovery capacity than its competitors during the subsequent global chip shortage crisis. This case illustrates how enterprises transform crises into opportunities for organizational learning and shift risk management from passive emergency response to active defense.

4.3. Comparison and discussion of the two cases

This subsection compares Apple and Toyota from three dimensions: risk type, response logic and organizational learning mechanism. The Apple case reflects spatial supply chain restructuring driven by political risks, a strategic-level decision concerning "where to produce". The Toyota case reflects institutional resilience construction driven by natural risks, an operational-level transformation addressing "how to produce". Although operating in different industries and confronting distinct risk categories, both enterprises converge on strategies including supplier diversification and digital capability development, jointly pointing to a resilience-building path of "multi-sourcing + dynamic buffering + digital monitoring". The cross-case comparison indicates that enterprises shall select matching strategies based on their dominant risk exposure, yet the core logic lies in enhancing system redundancy and flexibility to cope with uncertainties.

5. Response strategies for global supply chain risks

5.1. Risk prevention and buffering strategies

Drawing on the four-stage "Prediction–Protection–Buffering–Recovery" framework proposed in research on electronics manufacturing supply chain risk management, this subsection elaborates on the first two stages [14]. At the prediction stage, enterprises can leverage big data and artificial intelligence technologies to strengthen early perception of potential risks. At the protection stage, risk exposure can be reduced via supply chain network optimization, such as eliminating single-point dependencies and shortening supply radii for key materials. Furthermore, research has proven that the design of "multi-sourcing + dynamic buffer inventory" can effectively restrain risk transmission along supply chain networks while balancing cost control and adaptability.

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5.2. Risk response and recovery strategies

This subsection centers on the buffering and recovery phases of the four-stage framework. For buffering, differentiated safety stock levels shall be set according to the criticality of materials, paired with dynamic inventory allocation aligned with real-time market demand. For recovery, rapid activation of alternative suppliers and logistics channels serves as the core measure. Studies have verified that digital twin platforms enabling real-time mapping between physical and information domains can effectively coordinate cross-linkage responses and collaborative scheduling after supply chain shocks. From an industrial policy perspective, strengthening intra-regional circulation and developing localized production capacity for key industries are regarded as systematic approaches to improve recovery capacity.

5.3. Construction of a supply chain resilience system for multiple risks

Based on the foregoing analysis, four core elements of a resilience system for enterprises confronting overlapping risks are proposed. First, at the organizational level, establish the triple capabilities of supply chain agility (rapid response to changes), adaptability (adjusting configurations amid environmental shifts) and alignment (coordinating interests of all supply chain participants). Second, at the technological level, advance digital and intelligent transformation by deeply embedding digital twins, machine learning and other technologies into risk management workflows. Third, at the strategic level, integrate supply chain resilience into long-term corporate planning, shifting its positioning from a cost center to a strategic investment. Fourth, at the ecological level, build a collaborative risk governance network with upstream and downstream partners and government authorities. Meanwhile, the effectiveness of this system remains to be tested through more empirical research.

6. Discussion

This section comprehensively discusses the risk identification results and case strategies analyzed above, and further explores future development trends of global supply chains. First, starting from the fundamental trade-off between efficiency and security, it analyzes the core dilemma faced by enterprises in supply chain allocation decisions. The Apple case demonstrates that friendshoring mitigates political risks while inevitably driving up production costs, a contradiction that may permanently constrain the depth and pace of supply chain restructuring. Second, differentiated response space across industries facing identical risks is discussed: electronics manufacturing features high modularity, granting greater flexibility for supply chain reconfiguration, whereas automotive manufacturing is characterized by lengthy industrial chains and significant supplier lock-in effects, making resilience construction preferable over spatial relocation. Third, from a macro trend perspective, global supply chains continue to evolve toward diversification and regionalization, with three major manufacturing regional systems (North America, Europe and Asia) taking shape, which may fundamentally reshape the distribution and transmission mechanisms of supply chain risks in the future. Research on supply chain resilience assessment and risk transmission amid major unexpected shocks further corroborates this trend judgment [15]. Finally, practical implications of the research are discussed: enterprises shall choose appropriate solutions between production relocation and resilience development based on their industrial characteristics and primary risk exposure, and sustain investment in digital capabilities to accelerate perception and response speed amid complex risks.

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7. Conclusion

Centering on political, economic and natural risks facing global supply chains, this paper conducts systematic research and in-depth analysis of two typical cases—Apple's friendshoring initiative and Toyota's response to the Great East Japan Earthquake—drawing the following core conclusions: (1) Global supply chain risks are increasingly diversified and overlapping. Geopolitical conflicts, trade frictions and extreme climate events no longer exist as isolated exogenous shocks, but interweave and transmit in cascading manners to form systematic risks. Traditional single-dimensional risk assessment methods are inadequate to address such complexity. (2) Enterprises adopt two typical paths for risk response: spatial restructuring, namely capacity relocation (e.g., friendshoring, and nearshoring) to reduce exposure to geopolitical risks; and institutional construction, namely resilience system development (e.g., supplier diversification, higher safety stock, and digital monitoring) to enhance organizational adaptability to various uncertainties. (3) Effective supply chain risk management requires a full-lifecycle integrated framework. The four-stage "Prediction–Protection–Buffering–Recovery" model introduced in this paper provides an operable reference path for enterprises to deploy differentiated strategies across time dimensions, among which the "multi-sourcing + dynamic buffer inventory" design achieves a favorable balance between cost control and adaptability.

This research bears the following limitations: the selected cases only cover electronics and automotive manufacturing industries, so the generalizability of conclusions requires cross-industry verification; insufficient attention is paid to supply chain risk response strategies of small and medium-sized enterprises (SMEs). Future research can deepen exploration in three directions: first, investigating how emerging technologies such as artificial intelligence and blockchain reshape supply chain risk management practices; second, strengthening research on shock transmission mechanisms and coping strategies of SMEs embedded in global supply chains; third, developing more dynamic and predictive supply chain risk assessment models to deliver more precise decision support for enterprises amid high uncertainty.

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