Proceedings of ICEMGD 2025 Symposium: Innovating in Management and Economic Development
DOI: 10.54254/2754-1169/2025.LH26720

Innovation in Global Supply Chain Risk Management in the Post-epidemic Era

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Abstract. The ongoing impact of the COVID-19 pandemic has exposed the vulnerabilities in traditional supply chains, presenting both challenges and opportunities that drive the digital transformation and systematic innovation of supply chain risk management in the post-pandemic era. This paper reviews the feasibility of supply chain transformation by focusing on areas such as systemic restructuring of supply chains, big data innovation, fintech applications, collaborative logistics, and intelligent risk control. Big data can integrate heterogeneous data to improve risk prediction accuracy, but privacy security risks and data silos still constrain practical implementation; fintech's involvement in supply chain management can effectively enhance transparency between interactions, yet it carries the risk of weakening human intervention mechanisms; third-party logistics companies have increased information flexibility but face challenges of functional ambiguity and resource integration; intelligent risk control systems rely on artificial intelligence to achieve multi-party collaboration, but the marginalization of small and medium-sized enterprises due to technological inadequacies cannot be overlooked. The study finds that the synergy between technology inclusiveness and institutional innovation is the core path to resolving structural imbalances in supply chains and achieving resilient leaps. Today, innovations in technology application in supply chains must not ignore traditional organizational adaptability and coordination culture conflicts. This research emphasizes that technology inclusiveness and institutional innovation are key to supply chain risk management innovation.

Keywords: Post-epidemic era, Big data, Fintech, Dynamic assessment.

1. Introduction

In the first half of 2020, with the first large-scale outbreak of the COVID-19 pandemic, most industries around the world entered a state of shutdown. The pandemics transient, destructive, and unpredictable nature profoundly impacted the global public health governance landscape. Under the ongoing influence of the pandemic, the global supply chain system faced multiple challenges. According to data from the World Trade Organization (WTO), global merchandise trade fell by 5.6% in 2020, while global supply chain stress increased by about 4.5 standard deviations. The structural flaws exposed in traditional supply chain models during sudden public health events, such as node disruptions, international collaboration issues, and information asymmetry, have prompted both the business community and academia to focus on innovating risk management mechanisms.

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With the arrival of the post-pandemic era, the resilience of supply chains has gradually gained attention from businesses [1]. How to build a supply chain that can maintain production efficiency in long-term crises and ensure overall operations remain unaffected even when nodes are interrupted requires shifting the focus from traditional efficiency-oriented approaches to one centered on flexibility. In recent years, digital transformation has permeated all aspects, such as the application of artificial intelligence in the Internet of Things (IoT). IoT itself can connect various objects and devices through the internet, enabling capabilities like automatic scheduling and information monitoring. By integrating AI, its deep learning technology can uncover potential patterns and trends in vast amounts of data, thereby improving resource allocation and making more precise decisions. However, there are still many controversies in the practical implementation of technology empowerment, such as the bullwhip effect proposed by Hau Leung Lee, which may be overcome with the spread of digitalization, but the risks associated with algorithmic black boxes will also increase with greater reliance on technology. Notably, the distribution of benefits from technology empowerment is significantly uneven, highlighting the urgency of technological inclusiveness and institutional innovation.

Currently, a new management framework based on the deep application of digital technology and systematic strategy optimization is gradually becoming a research hotspot. This paper focuses on key areas such as digital reconstruction, big data analysis, financial innovation, logistics coordination mechanisms, and internet integration strategies. By integrating research findings from recent years both domestically and internationally, it systematically explores breakthrough practices in supply chain risk management during the post-pandemic phase, aiming to build a multidimensional reference system for deepening theoretical research and expanding industry applications.

2. New characteristics and challenges of supply chain in post-epidemic era

In the post-pandemic era, the resilience and flexibility of supply chains have gradually become the core objectives of corporate strategic adjustments. In their research, He and Gao propose that in the face of shocks caused by emergencies, the supply chain system urgently needs to rely on digital transformation for systematic restructuring [2]. This process not only requires long-term planning at the strategic level but also involves deep optimization of operational processes and reconfiguration of development paths. Empirical analysis shows that building a digital supply chain can effectively enhance a company's response efficiency to market fluctuations while strengthening multi-party collaboration capabilities. However, practical issues such as insufficient technological adaptability and rigid organizational structures still constrain the implementation process.

2.1. The double-edged sword effect of digital transformation

On the one hand, digital transformation is an event that enhances resilience, but as plans are implemented, many contradictions arise. For instance, the deep integration of the Internet of Things and artificial intelligence can improve resource scheduling efficiency and reduce corporate logistics costs. On the other hand, the insufficient widespread adoption of technology has led to the marginalization of small and medium-sized enterprises, further exacerbating the Matthew effect and hindering market competition.

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2.2. The strategic game between globalization and regionalization

In the post-pandemic era, supply chain layouts exhibit a trend of "global contraction" coexisting with "regional reinforcement." Multinational corporations are diversifying risks through strategies such as "nearshoring" (Nearshoring) or "friendshoring" (Friendshoring). . However, building a regional supply chain requires substantial initial investment and long-term ecological adaptation. This contradiction compels companies to seek a dynamic balance between efficiency and security.

3. Supply chain model innovation driven by technology

3.1. Big data driven risk management innovation

The widespread application of big data technology has opened up new avenues in supply chain risk management. Zhou emphasized in his research that companies can establish a dynamic risk assessment framework by integrating heterogeneous data sources such as transaction data, credit profiles, and logistics trajectories [3]. This framework not only supports refined risk prediction but also optimizes hierarchical control mechanisms. The core advantage of big data technology lies in its ability to integrate structured and unstructured data across domains. For example, Walmart used social media and weather data to predict demand during the 2020 hurricane season, increasing the turnover rate of bottled water inventory by 25%. In the manufacturing sector, Siemens leveraged the industrial internet platform MindSphere to collect real-time operational data from over 50 factories worldwide, using machine learning algorithms to predict equipment failure risks, helping customers reduce unplanned downtime by 30%. These practices demonstrate that expanding data dimensions and refining granularity can significantly enhance the spatiotemporal accuracy of risk predictions. Lian further found that while big data technology has significant advantages in optimizing credit evaluation systems and predicting market demand, the widespread existence of data silos and privacy security risks remain pressing challenges [4]. For instance, some small and medium-sized enterprises, constrained by weak technical foundations, struggle to effectively integrate into data-centric risk control systems, further widening the information gap between upstream and downstream entities in the supply chain. The EU General Data Protection Regulation (GDPR) requires companies to obtain explicit user consent for cross-border data transfers, leading to a 35% increase in the cost of data integration across multinational supply chains. Moreover, the lack of uniform data standards across industries further exacerbates information silos. For example, there are significant differences in data formats and collection frequencies between MES systems in automotive manufacturing and ERP systems in retail, requiring an additional 20-30% cost for data cleaning and alignment. While privacy-preserving computing technologies (such as federated learning and secure multi-party computation) can achieve "data availability without visibility," their computational demands significantly increase deployment costs for small and medium-sized enterprises, with only 12% globally possessing the necessary technical capabilities.

3.2. Fintech enables risk control of supply chain finance

In the field of supply chain financial risk management, the deep involvement of fintech is driving fundamental changes in traditional models. Research by Ying shows that the collaborative application of blockchain technology and artificial intelligence can significantly enhance the transparency of supply chain information exchange [5]. Taking blockchain technology as an example, its distributed ledger feature ensures the immutability of transaction records, thereby

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reducing the multi-level diffusion probability of credit risks. The TradeLens platform jointly developed by global shipping giant Maersk and IBM uses blockchain to track container logistics information, reducing document processing time from an average of 7 days to 24 hours and decreasing clerical errors by 30% . In China, Tencent Cloud's "Xingbei Cloud Chain" platform achieves full digitalization of accounts receivable financing through blockchain technology, compressing the SME financing approval cycle from 7 days to 1 hour and reducing annualized financing costs from 12% to 6%. According to a report by the World Economic Forum (2023), the fraud rate in supply chain finance using blockchain has decreased by an average of 25%. Meanwhile, smart contracts automatically trigger risk response instructions based on preset conditions, greatly improving the timeliness of risk management. However, Li and Zhang point out in their literature review that commercial banks need to be cautious about the potential limitations of technology applications when building end-to-end risk control systems [6]. Although fintech has achieved full-chain monitoring of credit processes, over-reliance on algorithmic decision-making may weaken the human intervention mechanism. The study emphasizes that financial institutions need to strike a dynamic balance between automated risk control and flexibility adjustment, avoiding the neglect of exceptional risks in complex scenarios due to technical rigidity.

4. Risk control

4.1. Risk co-governance of third-party logistics

In the risk management system of supply chain finance, the role of third-party logistics enterprises is gradually expanding from traditional services to the field of risk prevention and control. Scholars such as Liu have found through research from a logistics perspective that real-time tracking of cargo flow status and dynamic assessment of suppliers' performance can effectively reduce the risk of supply chain disruptions caused by information lag [7]. However, these enterprises face challenges in defining their roles in business practice. For example, in the case of cargo pledge financing, logistics companies not only need to fulfill basic responsibilities such as warehouse supervision but also take on additional functions like risk warning, which places higher demands on their resource allocation capabilities and technical integration levels. To address this issue, the research team recommends establishing a multi-party risk-sharing model. By setting up an information sharing mechanism and formulating a framework for responsibility allocation, they aim to promote a collaborative governance network among logistics companies, financial institutions, and suppliers. Such measures can not only optimize the efficiency of risk response but also enhance the sense of responsibility among participants through interest alignment, thereby systematically improving the stability of the supply chain finance ecosystem.

4.2. Smart risk control strategy under the background of internet +

In the context of deep technological empowerment by the Internet, innovative practices in supply chain financial risk management are gradually moving towards intelligence. Lin took a leading company A as her research subject, has developed a smart risk control system comprising four core elements [8]. First, leveraging artificial intelligence technology to dynamically capture abnormal transaction signals and build real-time risk warning models. Second, optimizing the synergy between capital flow and logistics operations to achieve dynamic alignment at key links in the supply chain. Third, collaborating with financial institutions and suppliers to establish a digital collaboration platform, breaking down information sharing barriers. Finally, introducing multi-layer

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encryption technology and real-time protection mechanisms to address cyber attacks and data breaches, reinforcing the security defense. Empirical data shows that the application of this framework has reduced the risk identification response cycle by about 60%, significantly enhancing management efficiency. However, the study also found that some small and medium-sized enterprises, constrained by technical thresholds and financial investment, find it difficult to integrate into such high-standard digital ecosystems, leading to their marginalization in the supply chain collaborative network. In response, scholars recommend reducing participation costs for SMEs through policy tools such as fiscal subsidies and technology incubation, while establishing tiered risk management standards to promote the inclusive development of smart risk control systems.

5. Inspiration and prospect

Current research achievements have made significant breakthroughs in the field of technological innovation, but there are still structural flaws in the theoretical system. First, the issue of insufficient organizational cultural adaptation has not been given adequate attention; most studies fail to deeply analyze the institutional inertia resistance and cultural conflicts encountered during digital transformation. Second, existing literature is often limited to case studies within specific regions, lacking a systematic deconstruction of the multidimensional pathways and spatial heterogeneity characteristics of cross-border supply chain risk transmission. Finally, the ethical boundaries of technology application remain unclear, and disputes over data sovereignty and the lack of privacy protection mechanisms have become prominent contradictions constraining industry development.

Future academic exploration should focus on the following directions: First, establish a quantitative analysis framework for assessing the resilience of transnational supply chains to reveal the vulnerability of key nodes in complex networks; Second, explore dynamic matching mechanisms between technology tool deployment and organizational capability evolution to resolve the "technology-management" synergy dilemma; Third, construct a game model for interest distribution under shared risk scenarios to balance the rights and interests of multiple stakeholders.

6. Conclusion

In the post-pandemic era, innovative practices in global supply chain risk management exhibit distinct characteristics of technology empowerment, multi-party collaboration, and full-cycle coverage. Big data analysis and financial technology innovation are gradually becoming key tools supporting risk management systems; however, their practical application must overcome three constraints: the feasibility of technology deployment, the adaptability of organizational structures, and the compliance with ethical norms. Of particular note, the excessive concentration of technical tools may exacerbate barriers to participation for small and medium-sized enterprises, leading to structural imbalances in the risk management ecosystem.

In this context, building a more inclusive risk management framework has become a consensus in academia. Future system design should focus on strengthening the dual-driven mechanism of policy guidance and ecosystem co-construction, such as lowering the digital access threshold for small and medium-sized enterprises through specialized technology incubation funds, or establishing cross-industry data sharing alliances to break down information silos. At the same time, it is necessary to embed a dynamic resilience assessment framework into supply chain network design, promoting the transition of risk management from passive defense to proactive adaptation. Ultimately, through the synergistic evolution of technological inclusiveness and institutional innovation, achieve a strategic leap in global supply chains from vulnerability repair to sustainable resilience construction.

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