GAS Journal of Economics and Business Management (GASJEBM)
Volume 3 | Issue 8, 2026 Homepage: https://gaspublishers.com/gasjebm-home/ ISSN: 3048-782X

The Impact of Artificial Intelligence on Supply Chains: Theoretical Evolution, Core Effects and Future Prospects

Junchao Yang, Wenxin Xu

Southwest Petroleum University, Chengdu, 610000, China

Received: *05.07.2026* | ***Accepted:*** *12.08.2026* | ***Published:*** *15.08.2026*

***Corresponding Author:** Junchao Yang

DOI: *10.5281/zenodo.21946656*

Abstract **Original Research Article**

In the VUCA environment, the development logic of supply chains has shifted from "efficiency-driven" to "resilience-driven". Artificial intelligence as a new generation of general-purpose technology is deeply embedded in supply chains. However, existing research lacks systematic integration. Based on 24 articles in the past two years, covering data from A-share listed companies, provincial panel data, and case studies, this paper adopts the methods of literature review and theoretical integration to construct a systematic analysis framework. The research finds that the impact of AI on supply chains is concentrated in four core dimensions: multi-dimensional enhancement of supply chain resilience, systematic reconstruction of supply chain structure, comprehensive optimization of operational efficiency, and precise prevention and control of various risks. It exerts its influence through three mechanisms: technological empowerment, organizational collaboration, and network spillover. Moreover, the empowerment effect shows significant heterogeneity influenced by enterprise, industry, regional, and environmental characteristics. At the same time, it faces challenges such as data and technology constraints, ethical governance dilemmas, and the absence of institutional standards.

Keywords: artificial intelligence; supply chain resilience; mechanism of action; hete-rogeneous characteristics; digital and intelligent supply chain.

1. Introduction

Against a global environment characterized by volatility, uncertainty, complexity and ambiguity (VUCA), supply chains, as the core link connecting production and consumption, are confronted with multiple challenges including optimized resource allocation and dynamic risk response. Driven by the Fourth Industrial Revolution, the development logic of supply chains has shifted from efficiency-driven to resilience-driven. Enhancing operational stability, risk resistance and sustainability has become pivotal for enterprises to survive and thrive (Ivanov & Dolgui, 2020; Modgil et al., 2022).

As a new generation of General Purpose Technology (GPT), Artificial Intelligence (AI) features adaptive learning and multimodal collaboration. It breaks the limitations of traditional technologies, penetrates deeply into all segments of supply chains, and triggers systematic transformations in operational models, structural forms and governance mechanisms (Toorajipour et al., 2021; Pournader et al., 2021). The rise of Generative Artificial Intelligence (GenerativeAI) has further expanded its application boundaries. The value realization and governance optimization of GAI in supply chains have become a prominent research hotspot (Queiroz & Wamba, 2024; Jackson et al., 2024).

Existing studies have conducted multi-dimensional explorations into the impacts of AI on supply chains and yielded fruitful outcomes, yet a systematic theoretical integration remains absent. From the perspective of theoretical evolution, this paper sorts out the core dimensions, operating mechanisms, heterogeneous characteristics and existing challenges of AI's impacts on supply chains, proposes future research directions, and constructs a theoretical framework, so as to support the high-quality development of supply chains in the digital economy era.

2. Theoretical Foundation

2.1 Resource Orchestration Theory

Resource orchestration theory holds that enterprises build competitive advantages through integrating, allocating and utilizing resources, which provides a critical perspective for explaining how AI improves supply chain performance. As a vital digital resource, AI itself possesses value creation potential. Furthermore, it elevates the overall performance of supply chains by optimizing resource allocation efficiency, facilitating resource collaboration and mitigating resource constraints.Dubey et al. (2024) further proposed a theoretical framework for generative AI-enabled operations and supply chain management practices based on a resource orchestration perspective.

2.2 Organizational Information Processing Theory

Organizational information processing theory argues that matching an organization's information processing capability with environmental uncertainty is the key to performance improvement. As a typical complex organizational system, supply chains are plagued by multiple uncertainties such as supply-demand fluctuations and information asymmetry. By enabling real-time data collection, intelligent analysis and accurate forecasting, AI enhances information processing capacity and effectively alleviates information frictions within supply chains (Belhadi et al., 2024).Belhadi et al. (2024) empirically found based on organizational information processing theory that AI's information processing capability has significant direct and indirect effects on supply chain resilience and performance.

2.3 Dynamic Capabilities Theory

Dynamic capabilities theory focuses on firms' ability to integrate, build and reconfigure internal and external competencies to address changes in a dynamic environment. AI empowers enterprises' dynamic capabilities including perception, adaptability and innovation, and thereby promotes adaptive transformation of supply chains (Modgil et al., 2022; Belhadi et al., 2024). Modgil et al. (2022) found that AI enhances supply chain resilience by strengthening dynamic capabilities such as visibility, risk management, procurement, and distribution.

3. Core Dimensions of AI's Impacts on Supply Chains

3.1 Multi-dimensional Improvement of Supply Chain Resilience

Enhancing supply chain resilience stands as the core value of AI empowerment. Relevant studies have verified its positive effects at four levels: individual enterprise, supply chain, industrial chain and export (Ivanov & Dolgui, 2020; Zamani et al., 2023).

At the enterprise level, generative AI improves the resilience of manufacturing firms by raising total factor productivity, with more pronounced effects on non-state-owned enterprises and those in central and western regions. AI also functions through two paths: product differentiation and exploratory innovation, and generates positive spillover effects on upstream suppliers. In addition, it stabilizes supply chains and expands sales channels to strengthen enterprises' export resilience.

At the supply chain level, AI is deeply embedded in traditional supply chains, driving their diversified, co-created and specialized development, and lifting both individual node resilience and network resilience. A case study on Mitrend shows that AI-driven human-machine interaction facilitates the three-stage evolution of supply chain resilience: from adaptive to sustainable and then to transformative (Modgil et al., 2022). The two-way spillover of AI adopted by core enterprises boosts overall supply chain resilience through resource allocation, cost reduction and collaborative innovation effects.Wamba and Queiroz (2022) further demonstrated that the integrated application of blockchain, AI, and big data analytics can significantly enhance supply chain resilience.

At the industrial chain and export levels, AI significantly enhances the resilience of manufacturing industrial chains, and its effect increases nonlinearly with the integration of digital and real economy technologies. Via inter-industry linkages, AI produces collaborative spillover effects, reduces unstable export relationships and lowers trade vulnerability.

3.2 Systematic Restructuring of Supply Chain Structure

AI breaks the linear structure of traditional supply chains and promotes their transformation toward diversification, networking, shortening and platformization. (Jackson et al., 2024). Jackson et al. (2024) proposed a capability-based framework for generative AI in supply chain and operations management, providing theoretical guidance for structural restructuring.

In terms of diversified supply chain configuration, AI broadens the scope of supply and demand options, elevates coordination and management capabilities, and reduces the concentration of upstream and downstream participants. It also facilitates enterprises' integration into supply chain networks through cost control and specialized division of labor, with more prominent impacts on enterprises in highly competitive sectors and downstream links of industrial chains.

In terms of spatial structure, industrial and supply chains present trends of shortening, nearshoring and localization. The chain-stabilizing effect of AI offsets efficiency losses caused by geographical distance. In terms of organizational form, platform-based supply chains have emerged as a new paradigm. Supported by AI as the core technology, all participants in supply chains can achieve efficient integration (Pournader et al., 2021).

3.3 Comprehensive Optimization of Supply Chain Operational Efficiency

Through technological empowerment and process reengineering, AI optimizes inventory management, resource allocation and cost control across the board (Toorajipour et al., 2021; Pournader et al., 2021).

For inventory management, AI addresses insufficient capital allocation and channel diversity, shortens inventory turnover days, and optimizes inventory allocation relying on real-time monitoring and data analysis. For resource allocation, it realizes accurate matching and efficient utilization via the path of intelligent data integration – algorithm optimization – technology-driven transformation. For cost control, AI compresses cost margins through specialized division of labor, logistics optimization and collaborative innovation.

3.4 Precise Prevention and Control of Supply Chain Risks

AI has established a new risk prevention and control system for supply chains, effectively coping with disruption risks, fluctuation risks and technological blockade risks (Ivanov & Dolgui, 2021; Belhadi et al., 2022). Ivanov and Dolgui (2021) proposed a digital supply chain twin framework, providing new means for disruption risk management.

In terms of disruption risk prevention, AI innovation improves demand forecasting capabilities and eliminates information barriers. It mitigates supply chain disruption risks via three paths: enhancing corporate reputation, upgrading intelligence level and cutting agency costs, delivering dual economic effects for internal and external operations.Belhadi et al. (2022) further constructed an AI-based supply chain resilience decision-making framework.

In terms of fluctuation risk prevention, general AI reduces the volatility of suppliers and customers, eases technological blockade problems, and smoothes the flow of information and physical goods without leading to supply chain rigidity.

In terms of information asymmetry risk prevention, AI does not alter information sharing strategies but greatly increases the value of information sharing, which is affected by technical maturity and demand elasticity.

4. Core Operating Mechanisms of AI on Supply Chains

4.1 Technology Empowerment Mechanism

The core logic of AI empowering supply chains lies in the deep integration of data intelligence and algorithm models. In digital and intelligent supply chain systems, AI integrates big data, Internet of Things and other advanced technologies. Supported by machine learning algorithms, it collects, monitors and analyzes full-link data in real time, digs out key information such as demand changes and inventory fluctuations, and realizes the automation and intellectualization of supply chain decision-making. It also transforms traditional supply chains from experience-driven mode to data-driven mode (Belhadi et al., 2022). The integration of digital and real economy technologies acts as a critical mediator: the deeper and wider the integration, the stronger it's supporting role in efficiency improvement and risk prevention.

4.2 Organizational Collaboration Mechanism

AI restructures supply chain collaboration modes and promotes dual upgrading toward human-machine collaboration and network collaboration. The human-machine interaction theory based on embodied AI cognition indicates that human-machine coordination in supply chain operations is not static adaptation, but a dynamic process evolving along with people's changing perception of AI capabilities. This dynamic collaboration serves as the core driver for the leapfrog development of supply chain resilience (Li et al., 2024). Li et al. (2024) empirically showed that supplier coordination and buyer coordination play a critical mediating role between the depth of generative AI usage and supply chain performance.

Meanwhile, AI breaks information and collaboration barriers between chain enterprises, builds interconnected network collaboration platforms, and promotes the efficient integration and optimal allocation of resources in procurement, production, logistics and other links. By reshaping collaboration processes and stimulating innovation vitality, it substantially improves the overall collaboration efficiency and core competitiveness of supply chains.

4.3 Network Spillover Mechanism

The impacts of AI on supply chain resilience feature prominent network spillover effects, mainly divided into two categories: two-way spillover and industrial linkage spillover (Wamba & Queiroz, 2022).

Within a single supply chain, the AI application achievements of core enterprises generate two-way spillovers through forward linkages (connecting downstream distributors) and backward linkages (cooperating with upstream suppliers). Relying on three paths including technology diffusion, experience sharing and standard co-construction, they improve the overall supply chain resilience. Such spillover effect is regulated by the technological gap between enterprises — the smaller the gap, the higher the spillover efficiency.

At the industrial level, AI produces cross-industry collaborative spillovers through industrial linkages. It not only strengthens the export resilience of upstream and downstream enterprises and stabilizes global supply chains, but also enables core enterprises to empower upstream suppliers and lift the resilience of the entire industrial chain.

5. Heterogeneous Characteristics of AI's Impacts on Supply Chains

5.1 Enterprise Heterogeneity

Enterprise characteristics significantly differentiate the empowering effects of AI. In terms of enterprise scale, large-sized enterprises with abundant resource reserves and specialized and sophisticated enterprises with in-depth technological research are more capable of capturing the dividends of AI technology.

In terms of ownership, private enterprises enjoy higher decision-making flexibility, so AI exerts a more remarkable empowering effect on them than on state-owned enterprises. In terms of enterprise life cycle, mature enterprises with sound operational systems can convert technological value more efficiently and gain greater benefits. In terms of resource endowment, enterprises with insufficient resources but high talent density can make up for resource weaknesses via technologies and give better play to the role of AI.

5.2 Industrial and Industrial Chain Heterogeneity

Heterogeneity across industries and industrial chains is also notable. Enterprises in highly competitive industries have stronger demands for optimizing supply chains via technologies, so AI plays a more prominent role in promoting their embedding into supply chain networks (Belhadi et al., 2024). Belhadi et al. (2024) also empirically verified that supply chain dynamism has a significant moderating effect on AI's empowering effect.

In terms of position in the industrial chain, the spillover effects of downstream enterprises and core enterprises vary greatly due to different technological gaps. For different industry types, traditional industries achieve transformation while capital and technology-intensive industries amplify their competitive edges with the help of AI, and both witness prominent empowering effects.

5.3 Regional and Environmental Heterogeneity

Regional and external environment profoundly affect the efficiency of AI empowerment. Regionally, enterprises in eastern China, areas with developed digital economy and high urbanization rate, as well as the Yangtze River Delta and Pearl River Delta urban agglomerations, benefit more thanks to solid industrial foundations and complete supporting facilities.

In terms of market environment, enterprises in underdeveloped markets rely more on technologies to break development bottlenecks, so AI delivers stronger empowering effects. Geographically, AI breaks spatial constraints and eliminates obstacles to long-distance collaboration. When facing high external uncertainty and fierce supply-demand fluctuations, enterprises are more dependent on AI to stabilize supply chains, and thus benefit more from its chain-stabilizing and resilience-enhancing effects (Belhadi et al., 2024).

6. Existing Problems and Governance Challenges of AI-enabled Supply Chains

6.1 Constraints at Data and Technology Levels

Deficiencies in data and technology greatly restrict the empowering effectiveness of AI on supply chains. Widespread data silos and the absence of data sharing mechanisms among supply chain participants result in insufficient and low-quality data for algorithm training and application, which undermines model prediction accuracy and decision-making effectiveness (Toorajipour et al., 2021).

Technically, the high cost of AI R&D, deployment and operation is unaffordable for most small and medium-sized enterprises (SMEs). Besides, existing technical solutions are mainly tailored for large enterprises and poorly adapted to SMEs. This further intensifies the Matthew effect and widens the development gap among enterprises.

6.2 Dilemmas in Ethics and Governance

The application of AI in supply chains is trapped in dual dilemmas of ethics and governance. Ethical risks spread across multiple dimensions: micro-level risks concerning data collection and usage security, meso-level risks related to fair market competition, and macro-level risks involving national industrial security (Queiroz & Wamba, 2024). Queiroz and Wamba (2024) explicitly identified in their exploratory study that generative AI in supply chain management faces challenges including security vulnerabilities, governance risks, and information errors.

Moreover, the black-box nature of algorithms leads to opaque supply chain decision-making, which may trigger decision deviations, ambiguous accountability and difficulties in liability investigation. The multi-stakeholder mixed governance system required by digital and intelligent supply chains lacks clear division of powers and unified integration standards, resulting in insufficient governance coordination and low efficiency. Current research pays limited attention to the above risks and governance issues.

6.3 Deficiencies in Institutions and Standards

Inadequate institutional guarantees and standard systems become major obstacles to AI empowerment. There is a lack of unified industrial specifications for AI application and quantitative evaluation indicators, which hinders the compatibility and interconnection of technologies across enterprises and supply chain links, and creates new collaboration barriers (Dubey et al., 2024).

Platform-based supply chains also face standardization challenges: their ecological architecture design, operation mode optimization and performance evaluation lack unified scientific guidelines, and relevant theories are still in the exploratory stage (Pournader et al., 2021). In terms of policy support, mismatches exist between policy supply and actual demand. Current policies offer insufficient support for AI-enabled supply chains, especially targeted policies to address the capital shortage and technological weakness of SMEs and meet industrial adaptation demands in remote regions.

7. Conclusions and Practical Implications

7.1 Research Conclusions

AI exerts multi-faceted impacts on supply chains, which are mainly reflected in four aspects: improved resilience, structural restructuring, operational efficiency optimization and risk prevention and control. It functions through three core mechanisms: technology empowerment, organizational collaboration and network spillover. Its empowering effects show significant heterogeneity affected by enterprise, industrial, regional and environmental characteristics. Meanwhile, the application of AI is confronted with multiple challenges including data and technological constraints, ethical and governance dilemmas, as well as inadequate institutions and standards.

7.2 Practical Implications

For enterprises, it is essential to deepen the integration of AI and supply chains and select application modes matching their own conditions. Core enterprises should give full play to spillover effects to drive the digital transformation of upstream and downstream partners (Li et al., 2024).

For governments, efforts should be made to increase investment in core algorithm R&D, build cross-enterprise data sharing mechanisms, improve technical standards and ethical norms, and implement differentiated supportive policies. It is also vital to foster a new ecosystem of digital and intelligent supply chains through high-level opening-up.

8. Future Research Directions

8.1 Exploring Configurational Paths of Multi-stakeholder AI Adoption

Most existing studies focus on the independent application effects of AI by single enterprises, while ignoring the interaction between multiple participants in collaborative supply chains. Future research should break the limitation of single-subject perspective, and adopt the configurational approach to analyze the combined effects of AI adoption by core enterprises, suppliers, logistics providers and other participants. It is necessary to identify the optimal application paths under different scenarios, and explore the synergistic effects and internal logic of the combined application of AI, big data, blockchain and other digital technologies (Wamba & Queiroz, 2022).

8.2 Quantitative Analysis on the Double-edged Sword Effect of AI

Current research mainly focuses on the positive empowering value of AI, while discussions on its potential negative effects are insufficient and mostly qualitative. Future studies need to construct a comprehensive evaluation system, and quantitatively measure the intensity of negative impacts brought by AI, such as restructuring of employment structure, algorithm bias and data security risks. Researchers should clarify the boundary conditions of AI's positive empowerment, and propose targeted mitigation mechanisms for negative effects to realize sustainable technological application (Queiroz & Wamba, 2024).

8.3 In-depth Exploration of Operating Mechanisms in Specific Scenarios

Existing literature mainly discusses general supply chain scenarios, with insufficient attention to differentiated characteristics of segmented scenarios, which limits the practical applicability of research conclusions. Future research shall combine the unique demands of segmented scenarios — such as cold chain temperature control for fresh food supply chains, logistics and compliance requirements for cross-border supply chains, and low-carbon emission reduction goals for green supply chains — to analyze targeted AI application modes and clarify the key influencing factors and operating mechanisms in different scenarios (Jackson et al., 2024).

8.4 Analysis on the Dynamic Evolution Mechanism of Multi-stakeholder Governance

Researches on supply chain governance in the AI era are fragmented and lack systematic and dynamic analysis, failing to meet the demands for the upgrading of supply chain resilience. Combined with the phased evolution of supply chain resilience, future research should explore the evolutionary rules of leading participants, behavioral patterns and governance priorities at different development stages. Ultimately, a modern supply chain governance system that can dynamically respond to changes and adapt to AI application scenarios should be constructed (Dubey et al., 2024).

References

Belhadi, A., Kamble, S., Fosso Wamba, S., & Queiroz, M. M. (2022). Building supply-chain resilience: An artificial intelligence-based technique and decision-making framework. *International Journal of Production Research, 60*(14), 4487–4507. https://doi.org/10.1080/00207543.2021.1950935

Belhadi, A., Mani, V., Kamble, S. S., Khan, S. A. R., & Verma, S. (2024). Artificial intelligence-driven innovation for enhancing supply chain resilience and performance under the effect of supply chain dynamism: An empirical investigation. *Annals of Operations Research, 333*(2), 627–652. https://doi.org/10.1007/s10479-021-03956-x

Dubey, R., Gunasekaran, A., & Papadopoulos, T. (2024). Benchmarking operations and supply chain management practices using generative AI: Towards a theoretical framework. *Transportation Research Part E: Logistics and Transportation Review, 189*, 103689. https://doi.org/10.1016/j.tre.2024.103689

Ivanov, D., & Dolgui, A. (2020). Viability of intertwined supply networks: Extending the supply chain resilience angles towards survivability. A position paper motivated by COVID-19 outbreak. *International Journal of Production Research, 58*(10), 2904–2915. https://doi.org/10.1080/00207543.2020.1750727

Ivanov, D., & Dolgui, A. (2021). A digital supply chain twin: Managing the disruption risks and resilience in the era of Industry 4.0. *Production Planning & Control, 32*(9), 775–788. https://doi.org/10.1080/09537287.2020.1768450

Jackson, I., Ivanov, D., Dolgui, A., & Namdar, J. (2024). Generative artificial intelligence in supply chain and operations management: A capability-based framework for analysis and implementation. *International Journal of Production Research*, *62*(17), 6120–6145. https://doi.org/10.1080/00207543.2024.2309309

Li, L., Liu, Y., Jin, Y., Cheng, T. C. E., & Zhang, Q. (2024). Generative AI-enabled supply chain management: The critical role of coordination and dynamism. *International Journal of Production Economics*, *277*, 109388. https://doi.org/10.1016/j.ijpe.2024.109388

Modgil, S., Singh, R. K., & Hannibal, C. (2022). Artificial intelligence for supply chain resilience: Learning from COVID-19. *The International Journal of Logistics Management*, *33*(4), 1246–1268. https://doi.org/10.1108/IJLM-02-2021-0094

Pournader, M., Ghaderi, H., Hassanzadegan, A., & Fahimnia, B. (2021). Artificial intelligence applications in supply chain management. *International Journal of Production Economics*, *241*, 108250. https://doi.org/10.1016/j.ijpe.2021.108250

Queiroz, M. M., & Wamba, S. F. (2024). ChatGPT and generative artificial intelligence: An exploratory study of key benefits and challenges in operations and supply chain management. *International Journal of Production Research*, *62*(16), 5676–5696. https://doi.org/10.1080/00207543.2023.2294116

Toorajipour, R., Sohrabpour, V., Nazarpour, A., Oghazi, P., & Fischl, M. (2021). Artificial intelligence in supply chain management: A systematic literature review. *Journal of Business Research*, *122*, 502–517. https://doi.org/10.1016/j.jbusres.2020.09.009

Wamba, S. F., & Queiroz, M. M. (2022). A framework based on blockchain, artificial intelligence, and big data analytics to leverage supply chain resilience considering the COVID-19. *IFAC-PapersOnLine*, *55*(10), 2396–2401. https://doi.org/10.1016/j.ifacol.2022.10.067

Zamani, E. D., Smyth, C., Gupta, S., & Dennehy, D. (2023). Artificial intelligence and big data analytics for supply chain resilience: A systematic literature review. *Annals of Operations Research*, *327*(2), 605–632. https://doi.org/10.1007/s10479-022-04983-y