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COLLABORATIVE MECHANISM OF DIGITAL TECHNOLOGY EMPOWERING GREEN SUPPLY CHAINS IN CROSS-BORDER E-COMMERCE

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Abstract: Currently, cross-border e-commerce is confronted with a dilemma regarding green transformation. On one hand, global climate governance mandates that enterprises to manage their carbon footprints. On the other hand, the lack of consistent carbon emission calculation standards across countries often places enterprises in a challenging position, where their environmental efforts remain unrecognized. This study aims to address this issue by investigating how digital technologies can effectively integrate various segments of the green supply chain. This study examines the collaborative mechanisms through which digital technology enhances the green supply chain in cross-border e-commerce. It aims to address the conflicts arising from differing carbon accounting standards and the risks of carbon leakage that cross-border e-commerce faces in the context of global climate change governance. By constructing a three-dimensional collaborative framework that includes the technological, business, and policy-ecological layers, the study systematically analyzes the applications of digital technologies such as blockchain, the Internet of Things, and big data. These applications are explored in relation to cross-border product traceability, intelligent warehouse optimization, precise supply-demand matching, and low-carbon route planning. Furthermore, the study investigates collaborative strategies in policy and ecology, including the unification of cross-border green standards and the development of a carbon asset financial product system. The research identifies technological standardization barriers and institutional frictions as the fundamental challenges currently confronting the collaborative mechanism. It concludes that technological innovation, institutional innovation, and capacity building are essential for overcoming these obstacles.
Keywords: Digital technology; Cross-border E-commerce; Green supply chain; Collaborative mechanism; Sustainable development

1 INTRODUCTION

Against the backdrop of accelerating global climate governance, cross-border e-commerce, a key driver of digital transformation in international trade, faces "dual institutional constraints" and "multidimensional technological challenges" in managing its carbon footprint. In March 2021, China's 14th Five-Year Plan, rooted in the strategic imperative of "dual carbon" (carbon peak and carbon neutrality), proposed a comprehensive green transition strategy. This plan precisely outlines the development pathway and explicitly advocates for the advancement of green technology innovation and the green transformation of key industries and critical sectors. Concurrently, the implementation of regional carbon tariff policies such as the EU Carbon Border Adjustment Mechanism (CBAM), set to fully take effect by 2026, has subjected cross-border e-commerce supply chains to dual pressures: conflicts in carbon accounting standards—such as discrepancies between China's MRV (Monitoring, Reporting, Verification) system and the EU ETS (Emissions Trading System)—and a surge in carbon leakage risks [1]. Meanwhile, global e-commerce carbon emissions continue to rise at an alarming annual rate of 9.3%, with cross-border logistics accounting for a staggering 58% of the total, far exceeding the average of traditional trade models. This contradiction underscores the strategic urgency of establishing a collaborative mechanism for carbon emission reduction in cross-border e-commerce.
The theoretical motivation for this study arises from two significant breakthroughs in existing research. First, traditional green supply chain studies primarily focus on individual enterprises or domestic contexts, often neglecting the interactive effects of cross-border institutional coordination and technology adoption. Second, research on carbon accounting within the digital economy typically overlooks the unique characteristics of cross-border e-commerce, such as "data sovereignty barriers" and "fragmented logistics networks," resulting in emission reduction strategies that fail to meet practical needs. On a practical level, by 2025, China's cross-border e-commerce comprehensive pilot zones for cross-border e-commerce are expected to encompass over 165 cities, yet their carbon intensity remains 17% higher than the national average, highlighting significant deficiencies in the incentive compatibility and technological adaptability of current policy tools.

2 LITERATURE REVIEW

2.1 Research Background and Current Status

Driven by the global carbon neutrality strategy and the digital technology revolution, research on collaborative innovation in green supply chains for cross-border e-commerce has become a focal point in interdisciplinary fields.

Core digital technologies, such as big data, blockchain, and the Internet of Things (IoT) integrate information flow, logistics, and capital flow, significantly enhancing supply chain visibility and operational efficiency [2] but also establishing a digital infrastructure for green technology applications. However, current practices still face multiple challenges: while supply chain digitalization reduces disruption risks, it necessitates dynamic resilience strategies to address potential threats [3]; blockchain-based smart contracts optimize trust mechanisms in cross-border payments but require improvements in the cross-border payment ecosystem's trust framework [4]; and the industry has yet to establish unified carbon emission accounting standards for full life-cycle assessments, among other critical issues that remain unresolved [5].

At the policy level, China's "Dual Carbon" strategy fosters paradigm shifts in green supply chains through institutional innovation, with manufacturing enterprises are adopting a dual-track mechanism combining green integration within industrial chains and green consolidation across supply chains. International practices, as indicated by UNCTAD statistics, reveal an annual growth rate of 14.7% in the global green consumer market, compelling firms to deeply embed ESG metrics into their supply chain decision-making systems. This trend highlights the necessity for synergistic design between digital technologies and cross-border environmental regulations [6]. Current research predominantly focuses on localized optimizations in procurement or production segments, leaving significant gaps in understanding the dynamic coupling mechanisms of digital technology-driven collaborative innovation in green supply chains. Urgent theoretical breakthroughs are needed in areas such as multi-stakeholder collaborative governance in cross-border e-commerce and the alignment of cross-border environmental regulations.

2.2 Research Progress at Home and Abroad

2.2.1 Domestic research

Domestic scholars have conducted research on model innovation and ecological synergy driven by digital technologies. Fang Yiru et al. proposed that Yunnan Province utilize cross-border e-commerce platforms and big data analytics to achieve transparent supply chain management and construct a green closed-loop system for the production and sales of specialty agricultural products. This approach increased supply chain responsiveness by 40% and reduced inventory backlog by 25% [7]. At the county-level economy, Li Nijie et al. found that the application of AI-based demand forecasting models in the crystal e-commerce sector of Donghai County, Jiangsu Province, improved resource utilization by 35%, while cloud computing optimized packaging design, reducing material waste by 20% [8]. In terms of policy mechanisms, Xia Wenhui et al. advocated for a collaborative framework involving the government, enterprises, and consumers in the fresh cold chain sector, leveraging digital platforms to share logistics information and reduce energy consumption [9].

2.2.2 International research

International studies focus on global industrial chains and collaborative governance. Amazon employs intelligent algorithms to optimize cross-border logistics routes, achieving an 18% reduction in carbon emissions from transportation within the European region. The European Union promotes blockchain technology standardization and mandates full lifecycle traceability for cross-border goods to enhance the efficiency of green certification in supply chains. Furthermore, Sarkis, J. proposed that digital technologies, such as blockchain and IoT facilitate green collaboration across supply chain segments through real-time data sharing and transparency mechanisms, effectively minimizing resource waste and carbon emissions [10]. Kshetri, N.'s empirical research confirmed that blockchain's tamper-proof traceability enhances the credibility of green certification in cross-border e-commerce supply chains, thereby promoting the coordinated development of international environmental standards [11].

3 DIGITAL TECHNOLOGY-ENABLED COLLABORATIVE MECHANISMS

Against the backdrop of rapid updates in the global carbon regulatory framework and the increasingly significant issue of carbon leakage in cross-border e-commerce, digital technology-enabled collaborative mechanisms have emerged as an effective approach to addressing dual challenges in both institutional and technological dimensions. This study constructs a three-dimensional framework encompassing the technological layer, business layer, and policy and ecosystem layer, integrating the latest international research findings from 2023–2024 to delve into the core theories and innovative directions of collaborative mechanisms. Key areas of focus include cross-border data flow regulations, integration of intelligent carbon accounting technologies, and multilateral digital governance agreements, among other emerging topics.

3.1 Technical-Level Collaboration

3.1.1 Blockchain-driven green certification and traceability system

Utilizing distributed ledger technology based on blockchain, a comprehensive traceability system for the entire lifecycle of cross-border goods has been established [12]. This system facilitates real-time recording of carbon emission data across stages such as raw material procurement, production and processing, logistics transportation, and end consumption. Smart contracts are utilized to automatically verify environmental compliance indicators, ensuring adherence to the EU's Extended Producer Responsibility (EPR) regulations. IoT sensors gather real-time data on temperature, humidity, energy consumption, and other parameters during cross-border transportation (e.g., carbon emissions from refrigerated containers), with the blockchain's immutable distributed ledger providing tamper-proof end-to-end records. A notable application is Alibaba International's green product rating system, which generates ratings based on production energy consumption data to assist overseas buyers in decision-making.

3.1.2 IoT and digital twin-enabled smart warehouse optimization

Digital twin technology utilizes virtual modeling to assess the energy efficiency and spatial utilization of various warehouse layouts. By leveraging IoT for real-time monitoring of environmental parameters within warehouses and integrating with Industry 4.0 technologies, it optimizes logistics routes and inventory configurations. This approach creates a cross-border supply chain management model that balances economic benefits with carbon reduction goals, achieving a win-win outcome for both economic and environmental objectives [13].

3.2 Business layer Collaboration

3.2.1 Big data and AI-driven precision in supply-demand matching

By leveraging historical transaction data and conducting social media sentiment analysis, this study develops a By integrating historical transaction data and social media sentiment analysis, a cross-border e-commerce demand forecasting model is constructed, employing LSTM neural network technology to dynamically adjusts procurement plans and inventory levels. A multidimensional data fusion analysis framework is established by combining e-commerce platform order data, social media sentiment analysis, search engine trend predictions, and seasonal fluctuation parameters. The model can simultaneously generate product popularity index maps to guide cross-border logistics route optimization and promotional pricing strategies [14]. A notable example is SHEIN, which applies AI algorithms to implement a small-batch rapid-response model, compressing the product design-to-shelf cycle to just 7 days while increasing inventory turnover by 40%, effectively reduces resource waste caused by overproduction .

3.2.2 Low-carbon route planning for multimodal transport networks

By integrating real-time carbon emission data from maritime, air, and rail transport (e.g., Maersk's Carbon Tracking API), a dynamic multimodal transport carbon footprint monitoring platform is built. IoT sensors collect real-time vehicle energy consumption data and interface with customs declaration systems. A multi-objective optimization model based on genetic algorithms has been established, with transportation cost, timeliness, and carbon emission intensity as constraints, and iteratively calculating the optimal transport routes. For example, in mixed China-Europe rail and maritime transport scenarios, the algorithm dynamically adjusts cargo distribution ratios between Ningbo Port and Hamburg Port, optimizing sailing speed settings in response to seasonal ocean current variations, reducing carbon emission intensity by 18%–25%. Additionally, blockchain technology facilitates paperless logistics documentation, thereby reducing cross-border customs clearance time.

3.3 Policy and Ecology Synergy

Cross-Border Green Standard Harmonization: Promoting the establishment of a mutual recognition system for green product certification within the RCEP framework requires forming a regional technical committee to conduct comparative studies on standards and evaluate the equivalence between China's "Green Product Certification" and the EU's "Eco-label." A multilingual online certification database should be developed to facilitate cross-border verification of certificates, thereby reducing redundant certification costs for enterprises. Policymaking may reference the EU's Carbon Border Adjustment Mechanism, requiring cross-border e-commerce platforms to disclose the full lifecycle carbon footprint of imported goods—from raw material extraction to final delivery—along with embedded carbon emission data. A carbon labeling tier system should be established to promote green transformation within supply chains.

Multi-Stakeholder Collaboration: Governments, platforms, and logistics enterprises should collaboratively establish a green supply chain alliance to share data and resources. The "Digital Economy International Cooperation Initiative for the Belt and Road" proposes accelerating digital economy cooperation with ASEAN and other Belt and Road regions by promoting the interconnectivity of key IT infrastructure, building multilateral and multi-level exchange mechanisms, strengthening digital skills training, and enhancing policy transparency in the digital economy [15].

4 PRACTICAL PATHWAYS AND CASE STUDIES

4.1 Technology-Driven Case: Alibaba's Practical Experience

As a global leader in e-commerce, Alibaba has built a vast supply chain network encompassing billions of products. Its intricate logistics and distribution system faces dual challenges of energy consumption and carbon emissions. To establish a green value chain collaborative ecosystem, the company is leveraging digital technologies to drive the transformation of its green value chain, integrating blockchain-based traceability systems and intelligent route optimization algorithms to create an environmentally friendly business ecosystem.

Alibaba employs an AI-driven intelligent warehousing system that leverages big data to analyze multi-dimensional information such as consumer purchasing behavior, geographic location, and inventory levels. This enables precise cross-border warehousing, reducing the delivery distance for international goods by 30% and significantly lowering energy consumption during transportation. [16] For example, in its global procurement business, popular products that previously required long-distance shipping from overseas warehouses to reach domestic consumers can now be pre-allocated to regional or forward warehouses closer to consumers, substantially reduces energy use and carbon

emissions in transportation.
This innovative approach effectively enhances logistics efficiency and reduces operational costs through digital technology, while also significantly decreasing energy consumption and environmental pollution during transportation. It serves as a practical reference for the e-commerce industry in building green supply chain systems and implementing digital supply chain management, guiding the sector toward efficient collaboration and sustainable development.

4.2 Policy-Driven Case: The EU's "Green Digital Trade Corridor" Initiative

The European Union has established a rigid framework for carbon governance in cross-border e-commerce through dual drivers of legislative coordination and digital infrastructure:

4.2.1 Mandatory compliance mechanism under the DMA

The Digital Markets Act (DMA), effective since 2023, requires ultra-large online platforms, such as Amazon to establish "Sustainable Product Zones." The Act defines "gatekeepers" like Amazon, Google, and Apple, mandating obligations such as prohibiting self-preferencing, enabling interoperability, and allowing users to uninstall pre-installed applications. Under the DMA, gatekeeper companies must meet specific criteria, including a market capitalization of at least €750 billion or an annual revenue of €75 billion, along with 45 million monthly active users and 10,000 business users in the EU. Violations of the DMA can result in fines of up to 10% of a company's global annual revenue, which can escalate to 20% for repeat offenders, and may also lead to restrictions on acquisitions. By 2024, the European Commission had initiated compliance reviews for six gatekeeper companies, five of which are U.S. tech giants. In response to this regulatory pressure, some companies have adjusted their strategies; for instance, Apple has allowed third-party app stores on iOS for the first time, while Meta's WhatsApp has gradually opened interoperability with other instant messaging services.

4.2.2 Cross-border green data exchange platform

This platform integrates customs and trade data interfaces from member states. For instance, Guangzhou Customs has achieved electronic origin data exchange with 18 regions while establishing an environmental information verification. A blockchain-based carbon footprint traceability system has completed end-to-end validation for cross-border carbon data certification in the Lingang New Area. Pilot data from 2024 indicated that the platform enhanced customs clearance efficiency by 30%, aligning closely with the efficiency growth curve of the General Administration of Customs for cross-border e-commerce. Its innovative "chain-based mutual recognition" data-sharing mechanism provides a replicable institutional model for overcoming international data sovereignty barriers.

4.2.3 Innovative practice of carbon tariff prepayment system

To address the policy challenges of the European Union's Carbon Border Adjustment Mechanism (CBAM), the platform has introduced an industry-first carbon tariff smart prepayment system, achieving full coverage for simulation calculations across five high-carbon industries, including steel and chemicals, on China's Green Trade Public Service Platform. With full lifecycle carbon emission tracking, this module enables businesses to accurately prepay carbon costs during the 2025 transition period, effectively reducing cross-border trade friction. Chinese cross-border e-commerce companies have mitigated potential carbon tariff risks amounting to billions through similar mechanisms. In 2024, China's cross-border e-commerce import and export volume reached ¥2.63 trillion, with carbon tariff dispute amounts aligning with industry estimates.

4.3 Market Innovation Case: SHEIN's Closed-Loop Sustainable Supply Chain System

Through technological integration and vertical industry collaboration, SHEIN has established a sustainable closed-loop system covering design, production, and recycling, driving low-carbon transformation within the fast-fashion industry:

4.3.1 Demand-driven low-carbon design system

A demand-driven, flexible supply chain model uses digital tools to monitor global fashion trends in real time and employs virtual sampling technology to minimize resource consumption in physical sample production. The company plans to launch a product carbon footprint traceability system in 2024, enabling consumers to access emissions data at each stage—from raw materials to recycling—on the purchase interface. This mechanism aligns with EU environmental regulations and fosters the growth of the green consumer market.

4.3.2 Distributed clean energy network

Deploying "solar + storage" systems in the Pearl River Delta region, SHEIN has successfully completed a rooftop solar demonstration project at its Guangzhou warehouse. Using new-energy trucks has reduced single-trip transport emissions by nearly 30%, while partnerships with companies like LONGi Green Energy are helping to establish a new-energy power supply network. Plans for 2025 include deploying over 130 new-energy electric vehicles, projected to cut annual carbon emissions by nearly 10,000 tons. The "solar + new-energy vehicle" model provides a practical template for greening warehousing and logistics.

4.3.3 Blockchain traceability in cross-border reverse logistics

To replace traditional fuel vehicles and reduce last-mile emissions, SHEIN promotes electric and two-wheeled vehicles for "last-kilometer" green delivery in the European market. It also optimizes sea and land transport to establish a low-carbon logistics network, decreasing air freight emission intensity year-on-year. Reverse logistics utilize recycled packaging materials, such as hemp bags, with these green logistics practices highlighted as an industry case study in the China Foreign Transport Sustainability Report.

5 CONCLUSION AND DISCUSSION

5.1 Deep-Level Challenges

5.1.1 Technical standardization barriers

(1) Data Interoperability Issues

Cross-border blockchain green certification systems suffer from protocol heterogeneity due to differences in technical architectures, leading to reduced efficiency of environmental information verification. For instance, the fundamental logic disparities between Hyperledger Fabric and Ethereum significantly increase the difficulty of data collaboration. Insights from China's Green Certificate Project illustrate that blockchain standardization is a core pathway to enhancing international recognition. However, the current lack of blockchain interoperability in cross-border e-commerce, particularly when promoting green goods within the EU—forces reliance on multi-node manual verification mechanisms for carbon label authentication, resulting in compliance costs exceeding industry expectations. This issue has been identified as a prominent case of global green trade technical barriers.

(2) Computing Resource Allocation Dilemma

Small and medium-sized enterprises (SMEs) face dual challenges of insufficient computing resources and a shortage of specialized technical teams when applying AI-based carbon accounting models. Research shows that although most enterprises depend on third-party cloud services, cross-border data sovereignty restrictions and associated compliance requirements significantly raise the costs of model localization. Innovations in blockchain technology for data security offer new solutions to address this issue..

5.1.2 Institutional friction

(1) Using China's photovoltaic module exports to the EU as an example, companies must simultaneously comply with the accounting requirements of both China's carbon emissions trading market and the EU's Carbon Border Adjustment Mechanism (CBAM). This dual regulatory framework imposes compounded carbon cost pressures. The 2024 industry report indicates that this situation has led to a significant decline in profit margins for Chinese cross-border e-commerce businesses targeting the EU. The case of Guangzhou's "Carbon Tariff Adaptability" green trade system further underscores the seriousness of this issue.

(2)The U.S. Inflation Reduction Act (IRA), through provisions such as localization requirements for battery components, compels Chinese new energy enterprises to restructure their supply chains. For instance, lithium battery manufacturers must adjust their global production layouts to meet IRA standards, leading to a surge in upfront investment costs. Research data in green technology indicates that such regional subsidy policies are profoundly reshaping the geographic distribution of global industrial chains.

5.2 Breakthrough Countermeasures

5.2.1 Technological innovation: lightweight tools and the open-source ecosystem

(1) Modular SaaS Carbon Management Platform

By promoting cloud-based carbon management tools, such as GreenVoyage's "Carbon Neutrality Solution," enterprises can utilize standardized API interfaces for seamless integration with ERP systems, facilitating automated carbon emission data collection and accounting. Pilot projects for carbon footprint certification in Guangdong Province have demonstrated the practical value of such digital tools. For example, manufacturers in the Pearl River Delta have successfully reduced manual intervention costs by optimizing carbon accounting processes, a practice further validated in Shenzhen's cross-border e-commerce overseas warehouse regulatory innovation case. The built-in MRV-ETS conversion module in these platforms also ensures precise alignment with EU CBAM requirements, providing technical safeguards for exporters to avoid duplicate accounting risks.

(2) Open-Source Green Technology Collaboration Platform

Leveraging international open-source communities, such as the Linux Foundation's ecosystem, facilitates shared development of AI carbon accounting algorithms and blockchain traceability modules. The technical collaboration mechanism proposed in Shanghai's Cross-Border E-Commerce Action Plan for Industrial Products offers SMEs a pathway to reuse open-source code libraries, significantly reducing technical barriers and accelerating the localized deployment of carbon management models. Case studies from Zhejiang Province's carbon account practices for foreign trade enterprises demonstrate that the reusability of open-source technologies enhances cross-border data trust. For instance, a cross-border e-commerce enterprise based in Hangzhou optimized its green certification process by adopting open-source blockchain protocols, creating a positive feedback loop with the technical adaptation of the Regional Comprehensive Economic Partnership (RCEP) cross-border data flow rules.

5.2.2 Institutional innovation: multilateral coordination and dynamic governance

(1) Carbon Data Governance Rules within the WTO Framework

It is advisable to establish a cross-border carbon data classification and hierarchical management system under the WTO framework, drawing on China's pilot free trade zone mechanisms for cross-border data flow management. This would allow the free flow of non-sensitive data (e.g., carbon intensity of packaging materials) while mandating localized storage for sensitive data (e.g., production process emissions). Pilot experiences in the Guangdong-Hong Kong-Macao Greater Bay Area in coordinating data sovereignty and carbon footprint governance, provide empirical support for this mechanism. Additionally, a multilateral carbon audit system could help resolve cross-border green trade disputes, with institutional innovations referencing successful paradigms from Beijing’s business environment optimization practices in aligning with international standards.

(2) Supply Chain Carbon Footprint Trusteeship System

International certification bodies can establish standardized benchmarks for regional carbon management through centralized accounting of industrial cluster emissions. Shanghai’s supply chain collaboration model in cross-border e-commerce for industrial products serves as a practical reference for such institutional designs. For instance, large-scale carbon verification in Shenzhen’s 3C product supply chains significantly reduces per-batch accounting costs, a benefit further supported by scale-effect cases in Guangzhou’s green trade system. The "Carbon Footprint Bank" model, which allocates carbon quotas across supply chains, offers SMEs a cost-sharing pathway for compliance. Research on Zhejiang’s cross-supply chain carbon account adjustment mechanism also underscores its effectiveness in optimizing SMEs’ technological empowerment and compliance cost structures.

5.2.3 Capacity building: integrating industry and education for financial empowerment

(1) The "Green Digital Supply Chain" Micro-Degree Program

Under the Ministry of Education’s "Digital Talent Cultivation Special Plan," universities have collaborated with leading technology firms to develop practical courses covering core skills such as carbon footprint modeling and blockchain traceability. This model, inspired by Shanghai’s technical collaboration model for industrial product e-commerce, addresses the shortage of applied skills. Pilot programs for "urgent-demand, application-oriented" micro-degrees have been launched nationwide, with some universities fostering interdisciplinary talent through courses like "Digital Technology and Financial Integration." For instance, the blockchain module in Hubei University of Education’s Digital Economy micro-degree enhances students’ technical application capabilities within green supply chains. This integration aligns with the vocational upskilling pathways outlined in the State Council’s "Low-Altitude Economy Industry-Education Integration Action Plan," significantly enhancing graduates’ competitiveness in green job markets.

(2) Policy-Based Financial Support System

Under the synergy of tech-finance and green supply chains, local governments are piloting green guarantee funds (e.g., Zhejiang’s cross-supply chain carbon account adjustment mechanism, to support distributed energy storage infrastructure. The clean energy technology promotion pathways proposed in the "Green Supply Chain Construction White Paper" provide a policy foundation for financial support in green transitions. Innovative financial instruments like carbon forward letters of credit, integrate carbon quota management with supply chain financing. The financial innovations within Fujian’s Industry-Education Integration Outstanding Engineer Program offer SMEs solutions for carbon asset capitalization. Cases of financial empowerment from the Greater Bay Area’s data sovereignty and carbon footprint coordination pilot demonstrate how vocational-education integration models can establish dual support mechanisms—technology-driven and capital-fueled—to sustain green supply chains.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

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REFERENCES

[1] H Q Hao, T Zhu. Research on environmental responsibilities of Chinese energy enterprises in the context of climate change litigation: Taking the "Royal Dutch Shell case" as an entry point. Journal of Chongqing University of Technology (Social Science), 2023, 37(2): 137–146.

[2] M Ben-Daya, E Hassini, Z Bahroun. Internet of things and supply chain management: A literature review. International Journal of Production Research, 2019, 57(15-16): 4719–4742.

[3] D Ivanov, A Dolgui, B Sokolov. The impact of digital technology and Industry 4.0 on the ripple effect and supply chain risk analytics. International Journal of Production Research, 2019, 57(3): 829–846.

[4] H Treiblmaier. The impact of the blockchain on the supply chain: A theory-based research framework. International Journal of Logistics Management, 2018, 29(3): 781–800.

[5] Y Huang, Y Luo, X Wang. Carbon footprint tracing of cross-border e-commerce supply chains: A blockchain-driven approach. Resources, Conservation & Recycling, 2021, 167: 105392.

[6] J Sarkis, Q Zhu, K H Lai. Digitalization and sustainability: A call for a digital green supply chain. Transportation Research Part E: Logistics and Transportation Review, 2021, 152: 102387.

[7] Y R Fang, M Q Peng, J Bai, S H Huang. Research on the construction of cross-border e-commerce ecosystem for characteristic agricultural products in Yunnan province. Sustainable Development, 2024, 14(4): 949–957.

[8] N J Li. Research on the development path of crystal e-commerce under county digital ecology. E-commerce Review, 2025, 14(1): 2482–2488.

[9] W H Xia, X Zhang, Q Y Xia, et al. Research on cold chain logistics and coordination of fresh agricultural products based on innovative supply chain. Journal of Chongqing University of Technology (Social Sciences), 2018, 2018(5): 85–92.
[10] J Sarkis. How Digital Technologies Enable Circular Economy and Sustainability in Supply Chains. International Journal of Production Research, 2021, 59(7): 2117–2138.
[11] N Kshetri. Blockchain and Sustainable Supply Chain Management in the Post-Pandemic Era. IEEE IT Professional, 2022, 24(3): 35–39.
[12] L X Zou, J Wu, M C Xia. The framework, implementation path, and challenges on information management of supply chain empowered by blockchain from the perspective of complex sociotechnical systems. Journal of Information Resources Management, 2023, 13(1): 91–102.
[13] S F Wamba, M M Queiroz. Industry 4.0 and Green Supply Chain Management: A Systematic Literature Review. Technological Forecasting and Social Change, 2022, 178: 121592.
[14] Y S Qin, F Xu. Research on the development of supply chain management in the internet context. E-Commerce Review, 2024, 13(4): 452–458.
[15] Digital Economy International Cooperation Initiative of the Belt and Road, 2018.
[16] L Li, et al. Digitalization and Green Transformation of Cross-Border E-Commerce: Evidence from Alibaba’s Green Logistics Initiative. Journal of Cleaner Production, 2023, 382: 135300.