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Green Upgrading Strategy of Supply Chain in the Age of Digital Intelligence Economy --Taking JD.com as an Example

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Abstract:

Against the backdrop of China's dual-carbon strategy and global sustainable development imperatives, how digital intelligence can enable the green transformation of supply chains has become a core issue for enterprises. This paper takes JD.com as a case study, systematically analyzing its practices in green logistics, smart warehousing, and eco-friendly packaging. The findings indicate that JD.com has achieved notable progress by leveraging digital and intelligent technologies to improve logistics efficiency, reduce carbon emissions, and enhance end-to-end monitoring. However, significant challenges remain, including insufficient coverage of green procurement, high carbon emissions in transportation, and underdeveloped recycling systems. This study investigates these dilemmas and proposes targeted strategies. The study further concludes that JD.com should not only build a digital green procurement platform and improve its recycling network, but also draw on international experience, promote upstream–downstream collaboration, and encourage user participation, thereby constructing a more systematic and sustainable green supply chain. Overall, the study underscores that digital intelligence serves a dual role: as a strategic enabler of corporate green transformation and as a source of replicable insights for platform-based enterprises pursuing sustainability.

Keywords: Green Supply Chain Management (GSCM); Digital Transformation; Case Study; Platform-Based Enterprises; Carbon Emission Reduction

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1. Introduction

1.1 Research Background

With the promotion of the national "dual-carbon" goal and the increase of international sustainable development pressure, the green transformation of the supply chain has become an important direction for the sustainable development of enterprises [1]. Against the background of the digital economy, how enterprises can use digital technology to embed different links in the supply chain effectively, promote green upgrading, and reasonably design the priority of the transformation strategy has become a core issue that needs to be studied and solved. As a representative Chinese enterprise that integrates digitalization and green development, JD.com's transformation practices offer significant insights and reference value. JD.com has carried out many explorations in green logistics, intelligent warehousing, and green packaging. Therefore, this paper will take JD.com as an example to explore and analyse the dilemma of green transformation in its supply chain, explore the specific path of green upgrading empowered by digital intelligence technology, and provide a reference for the sustainable development of platform-based enterprises.

1.2 Literature Review

Under the dual pressure of the global sustainable development agenda and national carbon reduction targets, green supply chain management (GSCM) has gradually become a research hotspot. Yan points out that the green transformation of the supply chain has been regarded as an important strategic path for enterprises to balance economic growth and environmental responsibility [1].

Recent studies have also demonstrated the driving role of digitalization in green transformation. Wang and Shen, using panel data from Chinese A-share listed firms, find that supply chain digitalization significantly enhances enterprises' green transformation performance, with the effect being more pronounced in non-state-owned enterprises, industries with high supply chain integration, and highly competitive sectors. This conclusion indicates that digitalization is not merely a tool for improving operational efficiency, but also a strategic mechanism for accelerating green transformation and strengthening corporate competitiveness [2].

Similarly, Stark et al. found that using digital tools in logistics and distribution processes can reduce transportation carbon emissions and enhance efficiency [3]. In addition, Fahmin et al. found that using AI for demand forecasting and route optimization can help reduce the carbon footprint of logistics [4]. Thus, these studies indicate that digital intelligence is simultaneously associated with efficiency improvement and environmental protection.

In contrast, it is challenging to encourage green transformation for platform enterprises. Hassamontr indicated that due to the large and multi-layered supplier network of large platform enterprises, it is challenging to enforce uniform green standards throughout the supplier network [5]. As shown in, compared with traditional enterprises, the structure of JD.com is more complex because it includes both self-managed logistics and a large third-party enterprise platform, which hinders the implementation of uniform green plans. Therefore, our research is focused on JD.com, which has both self-owned and third-party businesses. Suppose the logistics and procurement of a company are distributed across multiple industries, such as electronics and home appliances. In that case, the final degree to which the entire supply chain emission reduction is achieved is determined by the degree to which the company implements green procurement.

Although the aforementioned studies have achieved certain achievements, existing studies also found that there are still many challenges, such as fragmented suppliers, and it isn't easy to implement uniform green practices in complex supplier networks. These findings inspire us to conduct in-depth case studies, such as the research on JD.com in this paper, to explore how digital technologies can promote end-to-end sustainable upgrading.

1.3 Study Framework and Objectives

Firstly, the paper will introduce the evolution of JD.com's supply chain from self-built logistics to digital and intelligent logistics, and will review the phased achievements in green logistics, smart warehousing, and environmentally friendly packaging. This part will form the basis of the study by revealing both the achievements made and the gaps existing in JD.com's green development.

Secondly, the paper will analyze the key issues hindering JD.com's green upgrading, including the weak coverage of green procurement, high carbon emission levels in transportation, low efficiency of the recycling system, and lack of full-chain carbon monitoring. This part will also analyze how digital intelligence technologies can be utilized as potential solutions to improve efficiency and reduce environmental impact.

Thirdly, the paper will propose improvement strategies, including the establishment of a digital green procurement platform, improvement of the recycling and logistics system, cooperation with upstream and downstream partners, and introduction of advanced experiences from outstanding international enterprises like Apple.

Finally, the paper will summarize the key findings by highlighting the practical, social, and business significance of digital intelligence in enabling green upgrading in the supply chain. It will also point out the limitations of this study and outline possible directions for future research.

Through this logical sequence—from research background and current situation, to problem analysis, to proposed strategies, and finally to conclusion and outlook—the paper seeks to systematically demonstrate how digital technologies can empower the green upgrading of supply chains in platform-based enterprises.

2. Current State of JD.com's Green Supply Chain: Progress and Challenges

JD.com serves as a pioneering case of leveraging digital infrastructure to advance green supply chain initiatives in China. Since 2007, JD.com has gradually built a nationwide supply chain network through the establishment of its own logistics system. From the initial "warehouse-distribution integration" model to the recent adoption of smart warehousing, unmanned delivery vehicles, and big data scheduling platforms, its supply chain has shifted from being "scale-driven" to "data-driven and intelligent," while integrating the concept of green development. At present, JD.com has established a relatively complete green supply chain system covering procurement, warehousing, logistics, and packaging recycling.

In terms of green practices, JD.com has achieved phased progress across multiple areas. In warehousing, ten logistics centers have obtained the 'Green Warehouse' certification; as of 2023, the application of renewable energy and energy-saving technologies has cumulatively reduced carbon emissions by approximately 50,000 metric tons. In transportation, more than 10,000 new energy vehicles have been deployed, reducing carbon dioxide emissions by over 1,000 tons. In packaging, approximately 960,000 reusable boxes have been introduced, with more than 29,000 reuse cycles completed [6]. These measures have contributed to energy conservation, resource recycling, and the cultivation of greener consumer behaviors, indicating that JD.com has made significant strides in promoting supply chain sustainability.

Despite these notable achievements, a critical examination reveals that JD's green transformation is not without its challenges. Nevertheless, the development of JD.com's green supply chain still faces several limitations. First, the coverage of green procurement remains limited, with no unified environmental standards for suppliers. Second, although the scale of new energy vehicles continues to expand, overall transportation emissions remain high. Thirdly, the packaging recycling system is not yet widespread, and consumer participation is relatively low, due to insufficient incentive mechanisms and low public awareness, which prevents the creation of an efficient circular mechanism. Finally, ecological data tracking has not yet been integrated throughout the supply chain, so there is still room for improvement in terms of digital support. These issues indicate that the creation of an ecological supply chain at JD.com is still in the development and refinement stage..

3. Problem Analysis

3.1 The Limiting Effect of Uneven Digital Adoption

In terms of digital intelligence technologies, there are two important roles in the green supply chain transformation: One is to enhance the allocation efficiency of resources, which in turn decreases the carbon emission level of transportation [3]. It has been reported that integrating supply chain integration with big data analysis can substantially improve the supply chain resilience and agility in operations [7]. Under such circumstances, JD.com Logistics has been committed to further enhancing its automation, digitalization, and intelligent decision-making levels through basic technologies such as 5G, artificial intelligence, big data, cloud computing, and the Internet of Things. Through these efforts, the company has achieved better warehouse picking efficiency, higher vehicle load rate, and lower capacity procurement cost, which ultimately improve logistics efficiency and reduce energy consumption.

JD.com's "Asia No.1" smart logistics park is a typical case. The park has built an overall energy management system and continuously optimized the sorting and transportation process. Through the above efforts, highly efficient sorting is achieved, and carbon emissions are reduced. At the park level, priority should be given to street lighting powered by sunlight according to the condition of natural illumination. Park residents should also make full use of the renewable electricity resources generated in the park. In addition, distributed air conditioning should replace traditional boiler heating to realize precise local climate control and reduce fossil fuel consumption. Data indicate that compared with conventional coal-fired power generation, the park has saved approximately 1,210 tons of standard coal, which, according to carbon trading methodologies, equates to about 4,343.98 tons of CCER-certified carbon emission reductions [8]. Despite these improvements, the overall effect is still constrained by uneven technology adoption across regions and by the carbon intensity of upstream suppliers.

3.2 The Limiting Effect of Uneven Digital Adoption

Beyond the limitations in operational efficiency, another critical challenge lies in the monitoring and control of emissions across the entire supply chain. On the other hand, digital intelligence also plays an important role in

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strengthening supply chain process monitoring and control. By dynamically tracking and optimising the entire supply chain in real time, companies can increase transparency and reduce environmental pressures at the same time. Academic research has confirmed that AI-driven route planning and demand forecasting models can play a significant role in greening transportation, not only reducing unnecessary miles and empty loads, but also optimising capacity allocation by accurately predicting demand fluctuations. Thus, reducing carbon footprint [4].

JD.com's self-developed MRV-T (Monitoring, Reporting and Verification Technology) technology builds a multimodal transport carbon emission intelligent monitoring network covering sea, land, air, and railway, realising automatic matching of carbon intensity of transport modes, and providing a decision-making system for emission reduction optimisation. "JD.com has successfully enhanced the accuracy of carbon footprint accounting by adopting this technology, achieving significant results in carbon emission reduction that benefit a large number of consumers." These practices not only highlight the effectiveness of digital intelligence in green transformation but also provide replicable experiences for platform-based enterprises to explore the green supply chain.

3.3 Inefficiency of the Packaging Recycling System

In addition to energy and monitoring challenges, downstream waste management, particularly in packaging recycling, presents another significant hurdle. In recent years, JD.com has actively advanced green packaging initiatives, achieving initial progress. This practice represents a significant step toward reducing the use of single-use packaging materials such as cardboard boxes and plastic bags, thereby lowering resource consumption and waste generation. However, despite these initial successes, JD.com's packaging recycling system remains inefficient overall. The adoption rate of recyclable and reusable packaging remains limited, and consumer participation in the recycling process is relatively low. Without broader market recognition and a systematic closed-loop recycling mechanism, the potential environmental benefits of green packaging will be severely constrained. This inefficiency stems primarily from a lack of standardized recycling infrastructure, insufficient consumer incentives, and the high operational costs associated with reverse logistics.

Currently, JD.com's green packaging practices remain largely pilot-based. According to its ESG report, initiatives including reusable shipping boxes are primarily concentrated in select cities and specific business categories, failing to achieve comprehensive rollout across its entire logistics network [8]. This fragmented approach limits resource efficiency and hinders the scale required for long-term sustainability. Consequently, while JD.com has made positive strides in green packaging innovation, its role within the company's overall sustainability strategy remains underutilized. Substantial impact will require more systematic planning and heightened consumer engagement.

3.4 Challenges of Green Procurement

The supply chain of platform-based enterprises can be highly complex, as it involves all suppliers and customers associated with the company [9]. Within this system, the upstream stage is often the most emission-intensive, since raw material extraction, component manufacturing, and production processes directly determine the carbon footprint of the final product. Compared with downstream stages, upstream emissions are more dispersed and difficult to monitor, thus becoming the key challenge for green governance.

JD.com's procurement system covers multiple sectors, such as electronic products and household appliances, with a vast number of upstream enterprises. The coverage of green procurement, therefore, directly determines the overall emission reduction effectiveness of the supply chain. However, JD.com still faces several obstacles in advancing green procurement. First, many suppliers have not yet established unified green standards, and there is a lack of transparency in terms of raw material selection and information disclosure across different categories and regions. Second, small and medium-sized suppliers have limited capacity to invest in green transformation, lacking both the awareness and resources to take proactive action.

These issues make it difficult for JD.com to achieve holistic breakthroughs in supply chain decarbonization and contribute to insufficient transparency in upstream environmental performance. If the coverage of green procurement remains inadequate, even substantial investments in downstream sectors such as warehousing and logistics may be offset by high emissions from upstream activities, thereby undermining the overall effectiveness of emission reduction.

4. Suggestions

4.1 Learning from Apple's green procurement experience

In 2020, Apple mandated that all Tier 1 suppliers must use 100% renewable energy in their manufacturing processes. It established a rigorous carbon emissions data audit system, requiring suppliers to disclose their energy usage and carbon emissions regularly. According to Apple's 2023 Sustainability Progress Report, as many as 95% of suppliers (accounting for 95% of the company's direct man-

ufacturing expenditures) have committed to using 100% renewable electricity by 2030 [10]. In the Chinese market, more than 300 suppliers have joined the programme, accounting for more than 90 per cent of direct manufacturing spending [11].

This approach holds direct relevance for JD.com. As an e-commerce company operating both self-operated and platform businesses, JD.com's supply chain network is more complex and multi-tiered, involving not only its own direct suppliers but also countless third-party merchants. If JD.com were to draw on Apple's experience by establishing a digital green procurement platform, incorporating suppliers' environmental credentials and carbon footprint data into a systematic dynamic assessment, and leveraging digital intelligence technologies like blockchain for evidence storage and traceability, it could not only control supply chain carbon emissions at the source but also guide upstream partners toward green, low-carbon transformation through transparent environmental performance standards.

Yet, there is also much that JD.com can learn from Apple. At the same time as they recognize their similarities, it is also useful to recognize the differences. Apple has a relatively concentrated set of products and manufacturing for its supply chain, whereas JD.com, as a platform business, has a more dispersed set of suppliers and greater diversity in requirements. In many ways, this makes it harder for JD.com to enforce similar environmental standards across its supply base. Still, while following Apple's methodology in terms of their data analytics and stringency, JD.com may need to adapt it to their more dispersed ecosystem in terms of greater scalability, flexibility, and supplier support. Overall, however, the effectiveness of Apple's approach lies in the clear top-down mandate from the CEO, along with the disclosed data and strong monitoring. For JD.com, a more adapted model with more flexible mechanisms at different levels of supplier size or industry may also be feasible and effective..

4.2 Implementing A Tiered Incentive System to Drive Supplier Participation

In comparison to Apple's narrow manufacturing-focused supply chain, JD.com's supply chain is much broader and more complicated, including its own supply chain and suppliers on its platform. Therefore, JD.com urgently needs to build a systematic green governance mechanism to incorporate all suppliers of different levels and types into its emissions reduction mechanism.

In other words, JD.com can build a digital green procurement platform to incorporate suppliers' environmental credentials and carbon footprint information into a dynamic evaluation mechanism. Furthermore, digital intelligence technology, such as blockchain, data notarization, and traceability, can be achieved from the beginning to the end to ensure transparency and verifiability of information.

In addition, the green governance mechanism should not only focus on binding suppliers but also offer incentives. JD.com can build a supplier rating system to emphasize environmental performance and connect it with procurement. If suppliers with excellent environmental performance show up, they can be favored in JD.com's procurement contract or enjoy financial preferment in terms.

At the same time, if small and medium suppliers cannot act alone, technical and financial support should be provided by JD.com. We acknowledge that suppliers might feel constrained to push for green transition, as they might not have enough resources to be self-regulating. The support can be achieved through training programs, joint R&D in low-carbon technologies, or connections to green financing channels.

In the long run, by building such a governance mechanism, JD.com can not only reduce upstream high-carbon risks at their origins but also improve its image as a sustainability leader in China's e-commerce industry. As regulators pay closer attention to carbon emissions and consumers increasingly favour brands with environmental credentials, JD.com's internal governance in its supply chain can enhance its international competitiveness and brand image abroad.

Furthermore, through this governance mechanism, JD.com can also set an example for other platform-based enterprises, proving that large-scale digital ecosystems are capable of coordinating suppliers to achieve collective low-carbon development. Only through the combination of a transparent digital platform and an incentive system can suppliers be coordinated to achieve collective low-carbon development.

Ultimately, by embedding green governance into its supply chain strategy, JD.com can turn environmental sustainability from a binding obligation into a strategic direction for the company.

5. Conclusion

This paper examines the challenges and practices faced by JD.com in its green supply chain journey. The research results show that digitalization and intelligentization have become the key drivers for corporate sustainability, which can significantly improve logistics efficiency and carbon emission supervision. While challenges still exist in upstream procurement, such as a uniform green standard from suppliers, limited participation from small and medium enterprises (SMEs), and poor packaging recycling efficiency, these restrictions restrict the overall emissions reduction effect. Therefore, this paper proposes the following two recommendations: First, learn from Apple's experience in promoting the full usage of renewable

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energy in the supply chain and improving data disclosure from suppliers, and then integrate these good practices into the digital green procurement platform. Second, an effective green governance system should be built, which takes supplier environmental performance into account in procurement and offers necessary support to SMEs in their transformation into an integrated emission reduction effect. With these efforts, JD.com can play a stronger leadership role in the upstream supply chain and reach a more systematic and sustainable emission reduction effect. This also represents a shift from governing internal operations to governing the whole supply chain system. Platform-based enterprises need to reach Scope 3 emission targets.

5.1 Theoretical and Practical Implications

Beyond the case of JD.com, this research carries broader implications for both practice and society. It illustrates how platform-based enterprises can leverage digital intelligence not only to resolve internal efficiency issues but also to coordinate diverse stakeholders toward collective low-carbon transformation. Such insights are particularly relevant in the context of China's dual-carbon strategy and the global trend toward sustainable development. By embedding green governance into supply chain management, companies can transform sustainability from a compliance burden into a source of competitive advantage, thereby generating long-term value for businesses, industries, and society at large.

5.2 Limitations and Future Research

Nevertheless, this paper still has some limitations. The study mainly relies on secondary data such as corporate ESG reports and existing literature, and fails to fully incorporate primary data from suppliers, consumers, or internal stakeholders, such as qualitative insights into supplier resistance or the drivers of low consumer recycling participation rates, so the findings may not fully reflect the actual operational details or behavioural characteristics of supply chain participants. Additionally, while green transformation has become a prominent trend, its current implementation largely emphasizes carbon reduction and energy efficiency, potentially overlooking economic viability, industrial competitiveness, and social equity. Future research could explore the boundary conditions of green transformation, for example, under what circumstances "over-greening" may impose excessive costs on firms and weaken supply chain resilience. Subsequent studies could also employ surveys, interviews, or cross-industry comparisons to generate richer empirical evidence and more generalizable insights, thereby further advancing the understanding of how platform-based enterprises achieve effective and sustainable green supply chain transformation.

References

[1] Yan Yilin. The multidimensional impact of green supply chain management on economic, environmental, and social performance//Proceedings of the 5th International Conference on Artificial Intelligence and Computer Engineering. Wuhu, Shandong, China: ACM, 2024: 541-546.

[2] Wang Tao, Yang Shen. Unlocking the potential of supply chain digitalization for enhancing enterprise green transformation performance: Evidence from China. Humanities and Social Sciences Communications, 2025, 12(1): 1339.

[3] Andreas Stark, Kenneth Ferm, Robin Hanson, Mats Johansson, Siavash Khajavi, Lars Medbo, Mikael Öhman, Jan Holmström. Hybrid digital manufacturing: Capturing the value of digitalization. Journal of Operations Management, 2023, 69(6): 890-910.

[4] Fahmin Ahmed, et al. Eco-friendly route planning algorithms: Taxonomies, literature review, and future directions. ACM Computing Surveys, 2025, 57(1): 1-42.

[5] Hassamontr Jaramporn. On developing a supply chain visualization tool to manage product availability//2024 6th International Conference on Management Science and Industrial Engineering. Bangkok Thailand: ACM, 2024: 251-260.

[6] Paridhi, Neha Saini, and Charu Shri. Environmental, social, and governance reporting adoption factors for sustainable development at the country level. Environment, Development and Sustainability, 2025, 27(3): 8003-8042.

[7] Jiang Yisa, Feng Taiwen, and Huang Yufei. Antecedent configurations toward supply chain resilience: The joint impact of supply chain integration and big data analytics capability. Journal of Operations Management, 2024, 70(2): 257-284.

[8] Kumar, B. Rajesh. Case 20 JD.com Inc. Rising Stars: Integrative Case Studies on the 100 Fastest-Growing Companies. Cham: Springer International Publishing, 2024. 155-160.

[9] Hammi, Badis, Sherali Zeadally, and Jamel Nebhen. Security threats, countermeasures, and challenges of digital supply chains. ACM Computing Surveys, 2023, 55(14s): 1-40.

[10] Ruberti, Giorgio. Sustainability in Apple's Global Supply Chain: a comprehensive analysis of challenges, strategic initiatives, and performance optimization. Diss. Politecnico di Torino, 2024.

[11] Kwon, TaeHyung, and Soh Kim. Pioneering Renewable Energy Transition in the US: A Comparative Case Study of Google, Apple, and Microsoft's Utilization of Power Purchase Agreements. International Workshop on Cultural Perspectives of Human-Centered and Technological Innovations. Cham: Springer Nature Switzerland, 2024.